September 1954

MECHANICAL ENGINEERING

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ASME Annual Meeting, New York, N. Y.
Nov. 28–Dec. 3, 1954

There's no room inside for "frozen" thinking. For steam power progress will be measured in the future, as it has been in the past, by a lack of inhibition characteristic of Americans when they face engineering and financial problems.

No matter what you do, no matter what you make, the heat, light, and power you need must in large part come from coal, oil, gas and other fuels. And steam will be the medium for transforming the energy in those fuels into useable power. That's why it is important to you that B&W engineers tackle each new job with the determination that it can and must be an improvement over the excellent jobs that preceded it. Their thinking about how to give you cheaper power is not hampered by "sacred-cows" or slavish obedience to past practice.

Today, plants all over America are operating more efficiently because of B&W steam-generating improvements like Cyclone Steam Separators, coal pulverizers, advances in oil and gas firing, Cyclone Furnaces, pressure firing, high-temperature alloy steels, shop-assembled steam generators, use of increasingly higher pressures and temperatures, and waste-heat boilers and similar heat recovery equipment.

The door is open for tomorrow's contributions to the remarkable science of steam generation. You can rest assured that B&W engineers will continue to pioneer in the search for better ways to convert the raw energy which lies dormant in coal, oil, gas and other fuels into high-level, useable energy for the common good.

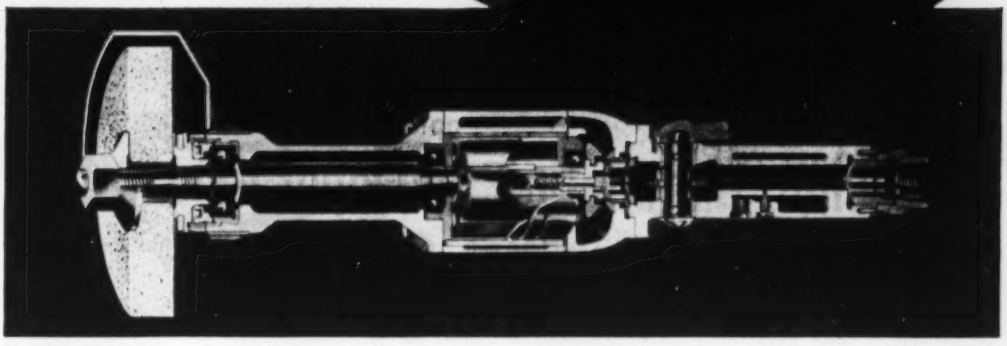
BABCOCK & WILCOX
BOILER DIVISION

N-185

With New Departures—

ROTOR GIVES UPKEEP THE "AIR"!

Rotor Tool Company design utilizes three New Departure **ball** bearings. Front bearing is wider to give greater surface on shaft and housing to withstand vibratory loads.

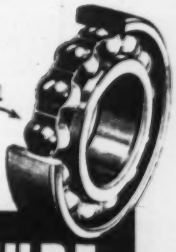


Holding the line against maintenance downtime! Three New Departures in the Rotor Tool air grinder need no adjustment . . . cut lubrication requirements to virtually zero.

These New Departure double-shielded bearings are protected from foreign matter. They have the high capacity to carry radial and thrust loads . . . to withstand the shocks of hard use and rough handling. At the same time, cool-running New Departure **ball** bearings maintain accurate alignment and assure maximum power at the grinding wheel.

You can build these advantages into *your* product, too. Talk with your New Departure engineer—*today!*

NOTHING ROLLS LIKE A BALL



NEW DEPARTURE

BALL BEARINGS

NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONNECTICUT

Plants also in Meriden, Connecticut, and Sandusky, Ohio

In Canada: Wilkinson Industries, Ltd., St. Catharines, Ontario

MECHANICAL ENGINEERING, September, 1954, vol. 76, No. 9. Published monthly by The American Society of Mechanical Engineers, at 20th and Northampton Sts., Easton, Pa. Editorial and Advertising departments, 29 West 39th St., New York 18, N. Y. Price to members and affiliates one year $3.50, single copy 50¢; to nonmembers one year $7.00, single copy 75¢. Postage to Canada, 75¢ additional, to foreign countries $1.50 additional. Entered as second-class matter December 21, 1920, at the Post Office at Easton, Pa., under the Act of March 3, 1879. Member of the Audit Bureau of Circulations.

SYNTRON ORIGINAL EQUIPMENT

gives you a headstart . . .

. . . on design, installation and operation

Each piece of Syntron Equipment is a complete unit. Can be operated individually or incorporated into automatic production systems. Simplifies design problems by eliminating the usual collection of extra accessories. Positive, practical hook-up arrangements permit easy installation and inspection.

ELECTRIC VIBRATORS

Keep even the most stubborn materials flowing freely through bins, hoppers and chutes. Deliver 3600 controllable vibrations per minute to prevent clogging, arching or plugging of hard-to-move materials. Prevent equipment damage by eliminating manual methods for loosening bulk materials.

VIBRATORY FEEDERS

Provide controlled feeding of most bulk materials from fine powders to heavy lumps. Finger-tip control of feeding rate permits handling at speeds from a few pounds to hundreds of tons per hour.

SELENIUM RECTIFIERS

Metallic, dry cell rectifiers that are almost indestructible for rough, severe service. No moving parts, high current capacity for nearly any installation requiring instantaneous a-c to d-c conversion.

INFRA-RED HEATING PANELS

For industrial heat processing, heat by direct radiation, do not use reflectors. Throw flat, intense heat pattern directly on the work. Operating efficiency remains the same regardless of length of production run.

SHAFT SEALS

Mechanical, self-lubricating, pressure balanced seals that prevent leakage of liquids and gases around the rotating shafts of pumps, turbines, compressors, etc.

PARTS FEEDERS

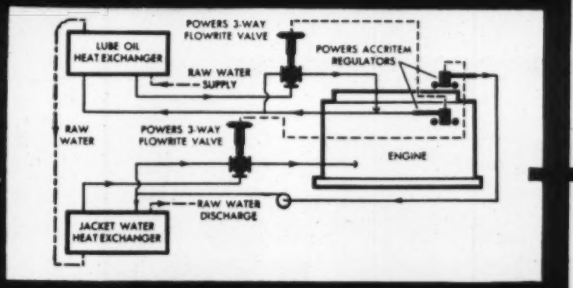
Completely automatic, single file, oriented handling of small parts of practically any shape or material. Feed parts at controllable speeds for assembly, inspection, packaging and other operations.

HOPPER CONTROLS

Flow Control Valves that provide positive shut-off or wide open pouring from bins, hoppers and chutes. Hopper Level Switches that maintain the maximum or minimum amount of materials in bins and hoppers.

Write For Complete Miniature Catalogue—FREE

SYNTRON COMPANY
498 Lexington Ave. Homer City, Pa.



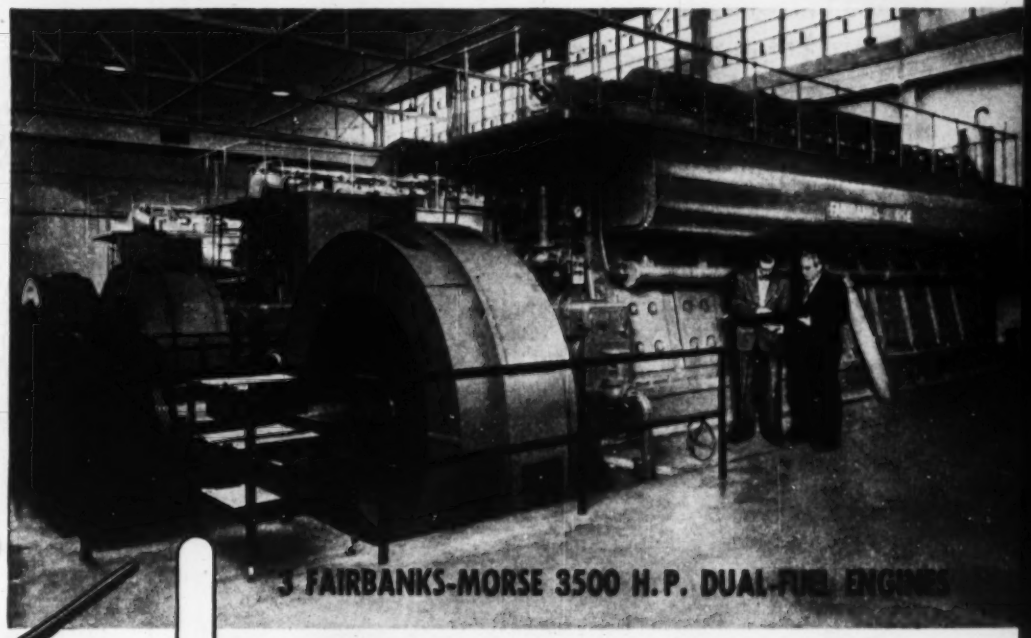
Right for the Job!

in the Hershey, Michigan Plant of

THE WOLVERINE ELECTRIC COOPERATIVE

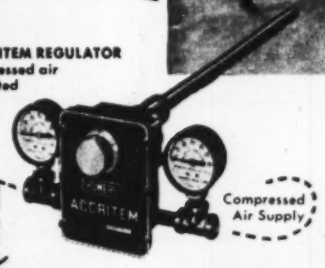
Most Efficient REA Plant

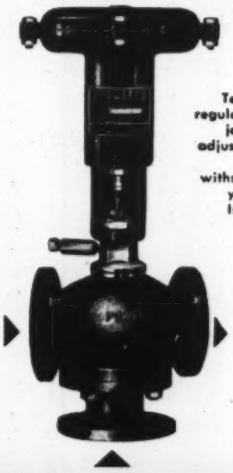
Winner of Award for most economically operated REA station in 1952. Six engines helped earn this distinction: 3 Fairbanks-Morse 3500 hp. Dual-Fuel Engines and 3 Cooper-Bessemer Dual Fuel engines. Consulting Engineers: J. & G. Daverman Co., Grand Rapids, Mich.



3 FAIRBANKS-MORSE 3500 H.P. DUAL-FUEL ENGINES

POWERS ACCRITEM REGULATOR below is compressed air or water operated





Six of these Regulators and six **FLOWRITE** valves control lube oil and jacket water used in the F-M engines above.

Temperature sensitive bulb of regulator is inserted in lube oil or jacket water line. Has easily adjusted temperature adjustment dial. Rugged construction withstands vibration and insures years of dependable service. Is unsurpassed for reliability and power to control diaphragm valves.

Left: POWERS 3-Way **FLOWRITE** Control Valve. Six 6" pipe size valves are used in the above installation. They have many superior features which make them especially suited for large engines.

POWERS Safeguards Engine Investment

with RIGHT Type of Temperature Control for LUBE OIL and JACKET WATER

For each engine or air compressor there is a "best temperature for the lube oil and cooling water". To insure that temperature at all times regardless of variations in load or seasonal changes in temperature of water supply, install Powers Thermostatic Regulators.

Powers Regulators have been time tested and proven reliable on many large and small installations. ACCRITEM Regulators and FLOWRITE Valves shown at left are unsurpassed for dependable control of large size valves. For smaller engines Powers No. 11 Self-Operating Regulators have been widely used for many years. Either of these controls can be applied to your present engines if they are not already protected.

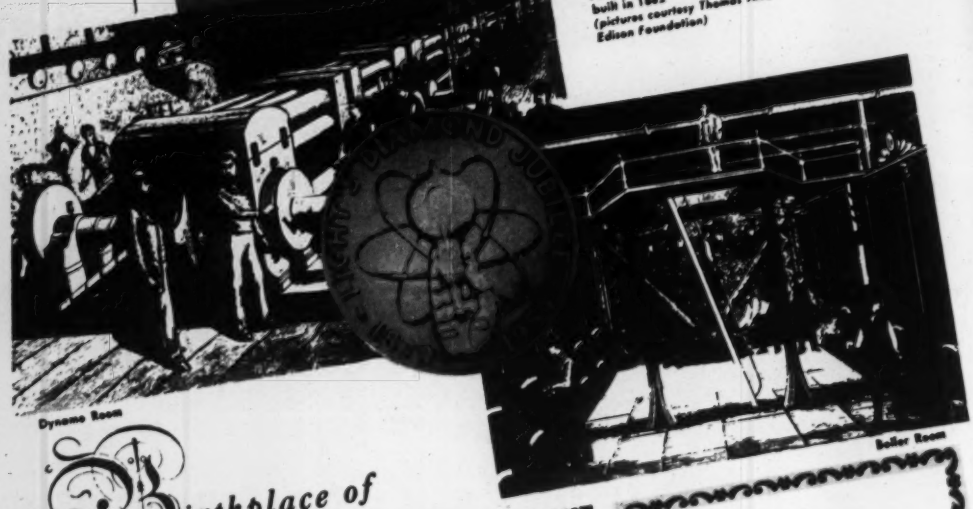
For the Right type Control for Your Engines or Air Compressors— contact Powers nearest office or write us direct. (b83)

POWERS CONTROLS

THE POWERS REGULATOR COMPANY

OVER 60 YEARS OF AUTOMATIC TEMPERATURE CONTROL

As a contribution to the utility industry's campaign to publicize "Light's Diamond Jubilee," Combustion Engineering has published this advertisement in current issues of Fortune and Business Week.



Pearl Street Station, New York, built in 1882 (pictures courtesy Thomas Alva Edison Foundation)

Dynamo Room

Boiler Room

Birthplace of

AMERICA'S INDUSTRIAL MIGHT

Though the machine age had existed for more than a century, Edison made it come of age. From his invention of the practical incandescent lamp in 1879 he went on to erect one of the most important industrial structures ever built—the Pearl Street central power station. This station was the forerunner of an industry which, as a source of light and power, changed the whole course of world development.

Electricity really began to make itself felt in America about 1900. By then, the average manufacturing worker had gained the electrical equivalent of two tireless helpers. *Today, the equivalent of 240 men help him on his job.* In this one dramatic fact is the underlying reason for our vast production capacity and high living standards.

Progress—both in efficiency and capacity—since the days of Pearl Street borders on the fantastic. For example, a turbine-generator is now being built which will have more than 2,000 times the capacity of one of the Pearl Street dynamos. And the C-E Boiler which will supply steam to this giant will be as high as a 15-story building—with a total volume greater than that of the entire Pearl Street Station and Edison's Menlo Park Laboratory combined.

This C-E Boiler, furthermore, will use less than ¾ of a pound of fuel to produce a kilowatt-hour of electricity, compared with 10 pounds at Pearl Street. To illustrate the significance of this achievement, suppose all the power in this country today were generated at Pearl Street's efficiency. Then, utilities would have consumed 2.4 *billion* tons, instead of the 178 *million* tons actually used in 1953. At present day fuel prices, this would have meant additional fuel costs of 17.7 *billion dollars*.

In this year of celebration of Light's Diamond Jubilee, Combustion Engineering—long associated with progress in power generation—is proud to pay tribute to the great and growing electric utility industry on the 75th anniversary of the invention that made it all possible.

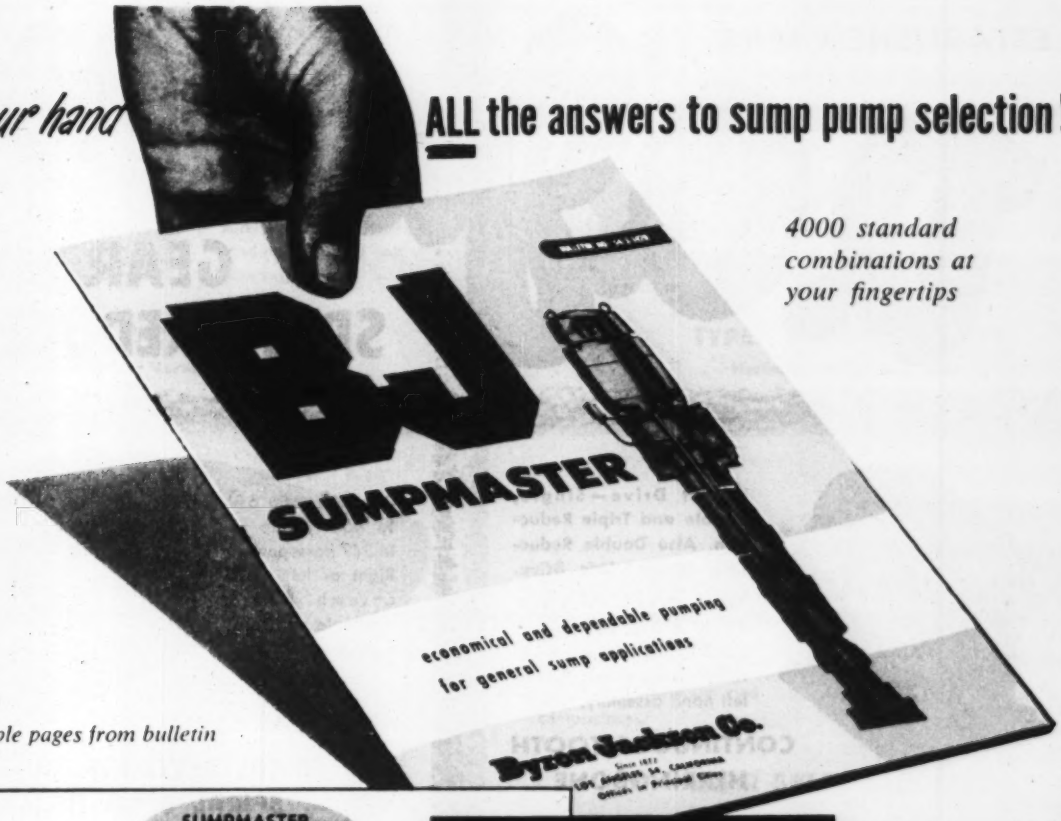
8-749

COMBUSTION ENGINEERING

Combustion Engineering Building • 200 Madison Avenue, New York 16, N. Y.

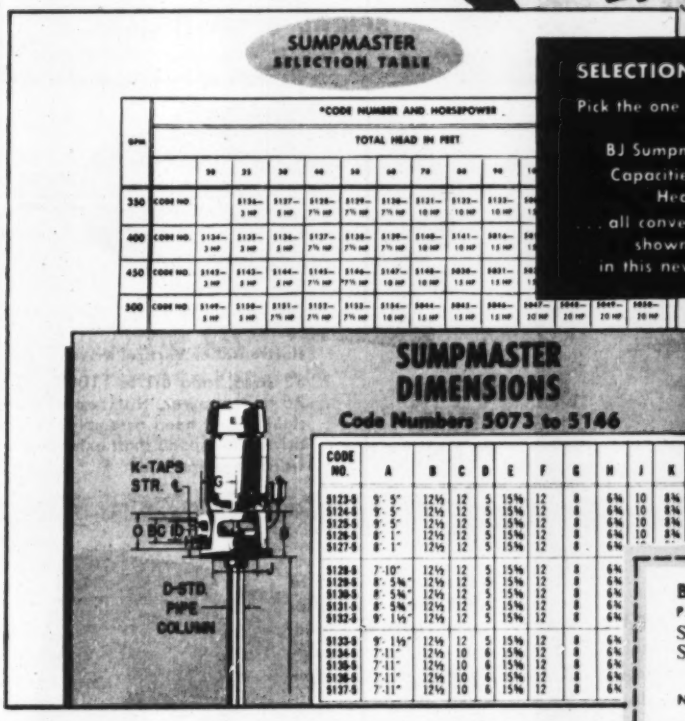
BOILERS, FUEL BURNING & RELATED EQUIPMENT; PULVERIZERS, AIR SEPARATORS & FLASH DRYING SYSTEMS; PRESSURE VESSELS; AUTOMATIC WATER HEATERS; SOIL PIPE

In your hand **ALL the answers to sump pump selection!**



4000 standard combinations at your fingertips

Sample pages from bulletin



SELECTION *right now*

Pick the one best pump for your job from 4000 standard BJ Sumpmaster combinations . . .
Capacities 10 to 2600 GPM
Heads 20 to 300 ft.
. . . all conveniently, concisely shown in easy selection charts in this new 20-page bulletin.

DIMENSIONS *right now*

You can draft exact specifications without a minute's delay. No waiting, no correspondence needed. This new BJ Sumpmaster bulletin provides complete dimensions and outline drawings.

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No special engineering or custom production delays are involved. Delivery can be made from Los Angeles, California, or Lawrenceburg, Indiana. Ordering is made easier by simple coding which eliminates detailed descriptions!

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Co. _____

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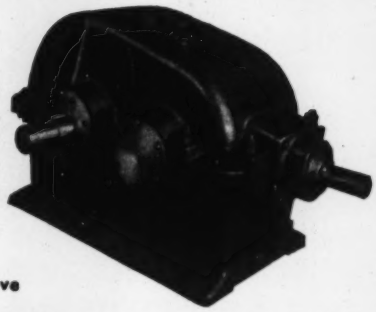
GEAR SPEED REDUCERS

Offset Drive—Single, Double and Triple Reduction. Also Double Reduction, Straight Line Drive.

110 sizes, ratio range from 2:1 to 370:1, and from .5 to 4700 horsepower. These reducers are either right or left hand assembly.

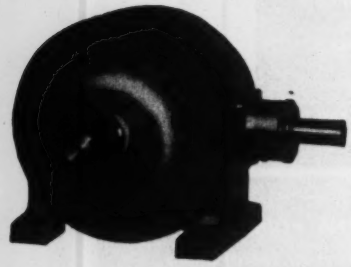
CONTINUOUS-TOOTH HERRINGBONE

38 sizes, ratio 6:1 to 450:1, with .3 to 347 horsepower. Right or left hand assembly. Also available vertically motorized.



Horizontal Drive

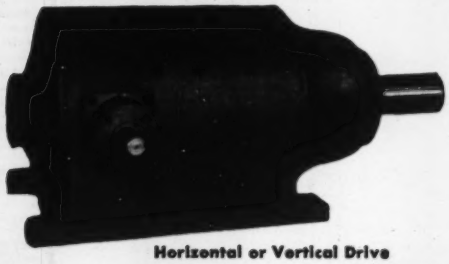
SPIRAL BEVEL-HERRINGBONE
SPIRAL BEVEL-HELICAL



15 sizes, ratio 1:1 to 6:1, .14 to 336 horsepower. Horizontal drive; right or left hand assembly. Vertical drive; slow speed shaft extending upward or downward.

SPIRAL BEVEL GEAR

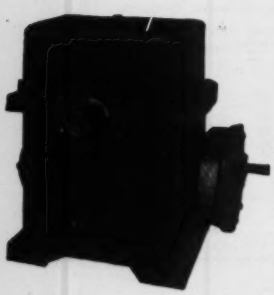
Horizontal or Vertical Drive



Horizontal or Vertical Drive

SPIRAL BEVEL-PLANETARY

33 sizes, ratio 8:1 to 1100:1, ¾ to 75 horsepower. Horizontal drive; right or left hand assembly. Vertical drive; slow speed shaft extending upward or downward.



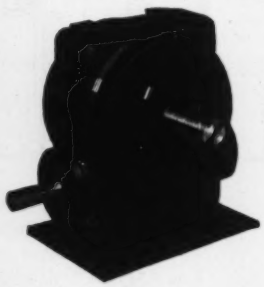
13 sizes, ratio 19:1 to 400:1, .13 to 72 horsepower. Horizontal drive; right or left hand assembly. Vertical drive; slow speed shaft extending upward or downward.

HELICAL-WORM GEAR

Horizontal or Vertical Drive

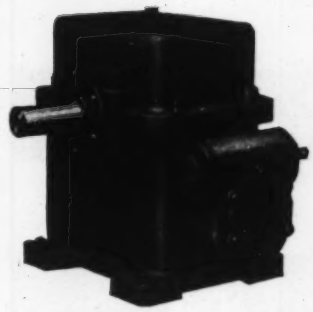
8 sizes, ratio 5.66:1 to 100:1, .04 to 15.6 horsepower. Horizontal drive; right or left hand assembly. Vertical drive; slow speed shaft extends upward or downward.

Sizes 17 to 33 inclusive have detachable bases or feet, are adaptable to horizontal or vertical applications, convertible from one to the other, or may be used without bases to suit particular installations.



TYPE "S" WORM GEAR

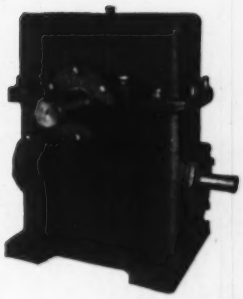
Horizontal or Vertical Drive



18 sizes, ratio 87:1 to 10,000:1, .004 to 60 horsepower. Horizontal drive; right or left hand assembly. Vertical drive; slow speed shaft extending upward or downward.

DOUBLE WORM GEAR

Horizontal or Vertical Drive



10 sizes, ratio 6:1 to 100:1, .30 to 206 horsepower. Horizontal drive; right or left hand assembly. Vertical drive; slow speed shaft extending upward or downward.

TYPE "H" WORM GEAR

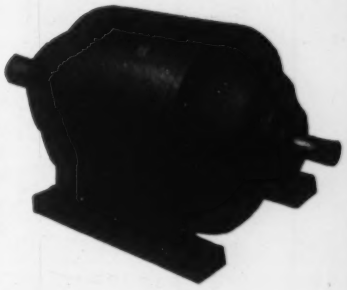
Horizontal or Vertical Drive

13 sizes, ratio 6:1 to 100:1, ⅛ to 30 horsepower. Horizontal drive; right or left hand assembly. Vertical drive; slow speed shaft extends upward or downward.

WORM GEARMOTOR

TYPE "W" • TYPE "WG"

Horizontal or Vertical Drive



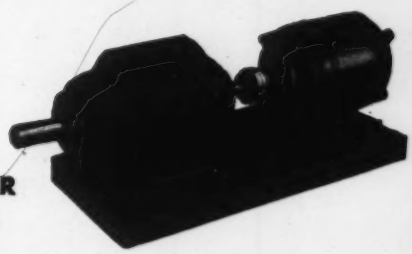
35 sizes, ratio 10 to 1200:1, ¾ to 75 horsepower. This arrangement of gears secures large speed reductions without sacrificing efficiency and compactness.

GEAR SPEED REDUCERS

GEARMOTOR REDUCER

TYPE "M"—Horizontal or Vertical Drive

35 sizes, ratio 10:1 to 1200:1, ¾ to 75 horsepower. Horizontal drive as shown. Vertical drive; slow speed shaft extending downward only.



GEARMOTOR REDUCER

TYPE "MR"

Assembled on baseplate with coupling. A packaged unit in 35 sizes. Ratio range 10:1 to 1200:1, ¾ HP to 75 HP.

GEARMOTOR REDUCER

TYPE "MG"—Horizontal or Vertical Drive

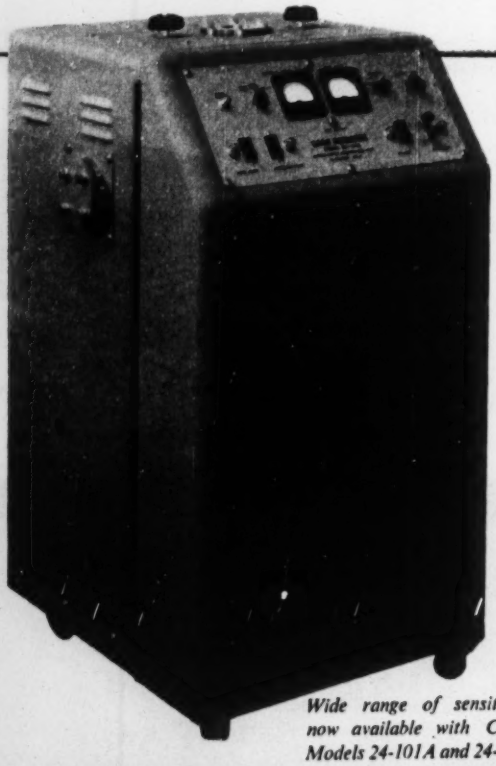
35 sizes, ratio 10:1 to 1200:1, ¾ to 75 horsepower. Horizontal drive as shown. Vertical drive; slow speed shaft extending downward only.

Sensitive to 1 part in 2,000,000

Consolidated's new Model 24-110 Leak Detector

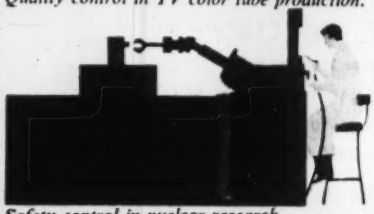
For leak detection applications where the utmost in sensitivity is required, Consolidated's new Model 24-110 Leak Detector meets the most stringent requirements. The latest addition to the Consolidated leak detector line is a modification of a high precision instrument built by CEC for the Atomic Energy Commission. Operating on the mass spectrometer principle made famous by CEC's widely used Model 24-101A industrial leak detector, the sensitivity of the 24-110 has been multiplied by a factor of 10 through advanced electronic techniques. Its uses include testing of both evacuated and pressurized equipment, revealing the existence or the absence of leaks, finding the locations of leaks, and determining the rates of leakage. Outstanding features include: an audible alarm whose sound-pitch varies with the magnitude of the leak; an accessory sampling probe for rapid pressure-system leak testing; a selector switch that provides six ranges of sensitivity; a visual leak-rate meter capable of indicating the presence of 1 part helium in 2,000,000 parts air. Compact, self-contained and mobile, Consolidated's new Model 24-110 Leak Detector is a perfect tool for highly critical applications such as detection in ultra high vacuum laboratory equipment, leak-checking of TV color tubes, and safety control in nuclear material manufacturing.

Request Bulletin CEC 1838-X7



Wide range of sensitivity now available with CEC Models 24-101A and 24-110.

Quality control in TV color tube production.



Safety control in nuclear research.

Leak detection for ultra-high vacuum equipment.

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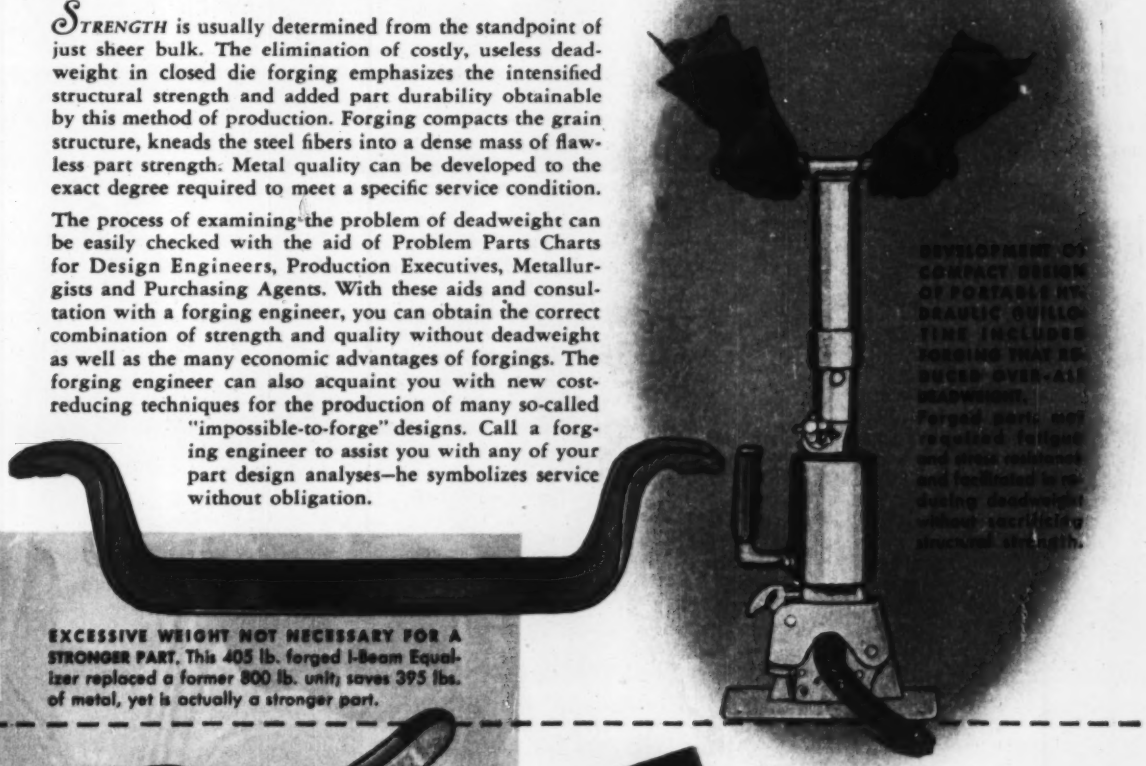
Forgings...

don't need "Deadweight" to make them TOUGH and STRONG

STRENGTH is usually determined from the standpoint of just sheer bulk. The elimination of costly, useless deadweight in closed die forging emphasizes the intensified structural strength and added part durability obtainable by this method of production. Forging compacts the grain structure, kneads the steel fibers into a dense mass of flawless part strength. Metal quality can be developed to the exact degree required to meet a specific service condition.

The process of examining the problem of deadweight can be easily checked with the aid of Problem Parts Charts for Design Engineers, Production Executives, Metallurgists and Purchasing Agents. With these aids and consultation with a forging engineer, you can obtain the correct combination of strength and quality without deadweight as well as the many economic advantages of forgings. The forging engineer can also acquaint you with new cost-reducing techniques for the production of many so-called "impossible-to-forge" designs. Call a forging engineer to assist you with any of your part design analyses—he symbolizes service without obligation.



EXCESSIVE WEIGHT NOT NECESSARY FOR A STRONGER PART. This 405 lb. forged I-Beam Equalizer replaced a former 800 lb. unit; saves 395 lbs. of metal, yet is actually a stronger part.

CHANGING TO DROP FORGING, PRODUCT NOW WEIGHS 28 LBS. LESS. Manufacturer of this Plate Grip for handling steel plate obtained the extra benefits of safety and strength without increased cost.

This book tells why forgings are used for the toughest work loads. Engineering, production and economic advantages obtainable with closed die forgings are presented in this reference book on forgings. Write for copy today or attach coupon to your business letterhead.

A New full color 33 min., 16mm. Movie entitled, "Forging in Closed Dies", reveals all aspects of the closed die forging process of forming parts. Represents over ten years of planning and research. It is available for industrial training, sales training, instruction in engineering and metallurgy courses at the college level, and for technical, industrial and engineering societies. Write for information about loan of film without cost.

DROP FORGING ASSOCIATION

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Please send 64-page booklet entitled, "Metal Quality" — How Hot Working Improves Properties of Metal." 1953 Edition.

Name .....

Position .....

Company .....

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Progress is built

Fairbanks-Morse will also continue to supply electric motors in *old* NEMA frame sizes.

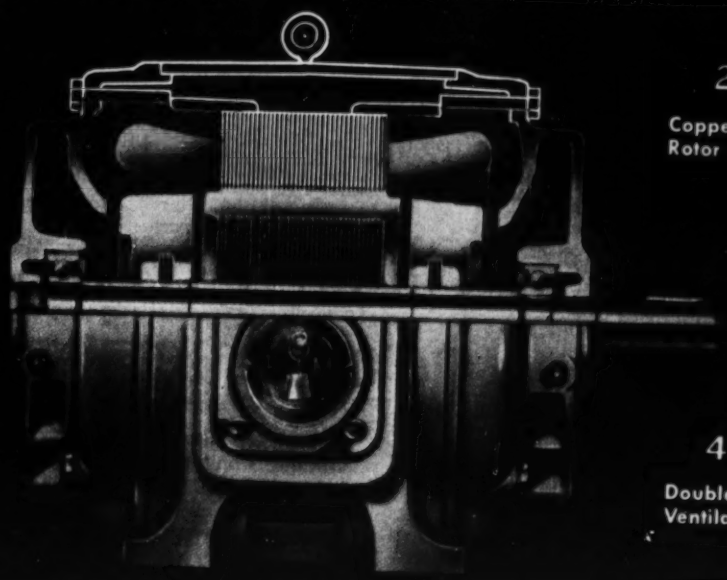
. . . brick by brick

The new NEMA Standard for electric motors is a significant sign of progress to all industry—More Power in Less Space.

But progress—to be lasting—must be built brick by brick For more than a century, Fairbanks-Morse designers have held to the ideal of more performance in less space. They have produced outstanding advancements in the design of diesel engines, pumps, scales, locomotives and the many other products that feature F-M exclusives. Fairbanks-Morse electric motors built on this basic F-M engineering philosophy are continuing assurance of operating economy and efficiency.

Look for the electric motor that stands on this Fairbanks-Morse solid foundation of design progress. It carries the Fairbanks-Morse Seal of Quality.

NEW FAIRBANKS-MORSE GUARDED DRIPPROOF MOTORS



1 Guarded, dripproof construction keeps falling objects and dripping liquids out of motor in any mounting position—maximum motor protection under conditions of wet or dirty operation—indoors or out.

2 Exclusive Fairbanks-Morse feature that provides a virtually indestructible one-piece rotor—homogeneous, free from flaws and gas inclusion for maximum strength and lifetime service.

3 Oversized, precision ball bearings in spacious housings, sealed against grease leakage. Contain ample lubrication for extended periods of rugged service. Convenient flushing and re-lubricating available if desired.

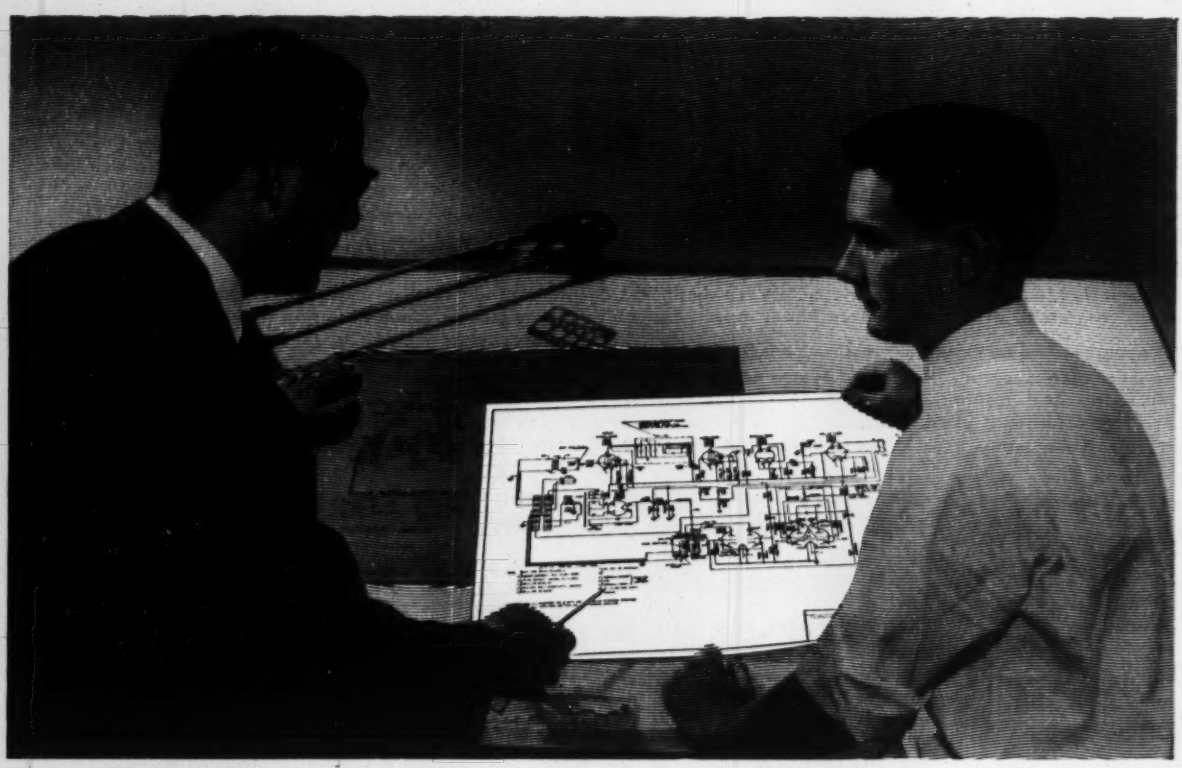
4 F-M exclusive design eliminates hot spots. Cooling outside air is drawn into motor through openings in lower portion of both bearing arms and circulated through cored passages in the frame.

5 New, gasketed, cast iron conduit box permits easy pulling of cables without insulation damage. Fairbanks-Morse exclusive: recess feature allows elimination of conduit box where space is limited.

FAIRBANKS-MORSE

a name worth remembering when you want the best

ELECTRIC MOTORS AND GENERATORS • DIESEL LOCOMOTIVES AND ENGINES • PUMPS • SCALES • RAIL CARS • HOME WATER SERVICE EQUIPMENT • FARM MACHINERY • MAGNETOS



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Peerless Cloth gives you faultless reproduction...

VERY HIGH IMAGE DENSITY: The high silver content of the emulsion, made to Peerless' own formula and carefully quality-controlled, gives deep rich blacks and good clean whites in striking contrast. Copies linework sharply and clearly, including very fine pencil lines. Reproduces all letters and numerals without filling.

GREATER TRANSLUCENCY: The highly transparent base fabric, obtained by friction-calendering fine quality long-staple cotton cloth, is made evenly translucent by applying a waterproof plastic coating. Translucency is carefully checked for uniformity over the entire area and from roll to roll. Result is clear, sharp reproductions by either blueprinting or the diazo process.

BETTER WEARING PROPERTIES: Peerless Cloth is more flexible, won't crease or crack or abrade even under severe handling. Doesn't curl up at the edges no matter how many passes it makes through the printer. Erases easily, has a good tooth for redrawing after eradication, and takes ink readily without feathering. Extremely high bond-strength insures that neither the emulsion nor the sub-coating will peel from the base cloth during processing.

Peerless Cloth is available in white or in blue, coated with either Tru-Flex standard-speed emulsion or Projection high-speed emulsion. Its quality is carefully checked at each of 46 manufacturing operations.

PEERLESS PHOTO PRODUCTS, INC. ME-9
Shoreham, L. I., New York

Please ask your distributor nearest me to send me a sample of Peerless Reproduction Cloth.

☐ TRU-FLEX ☐ PROJECTION

NAME _____

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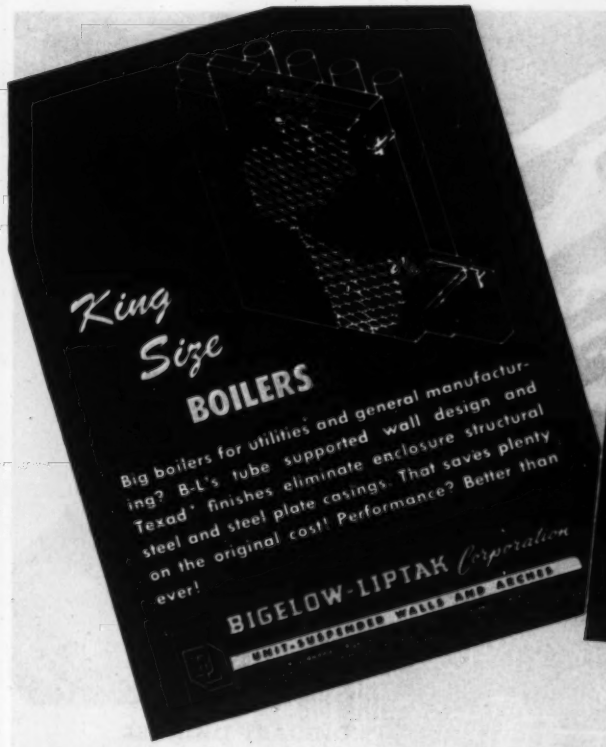
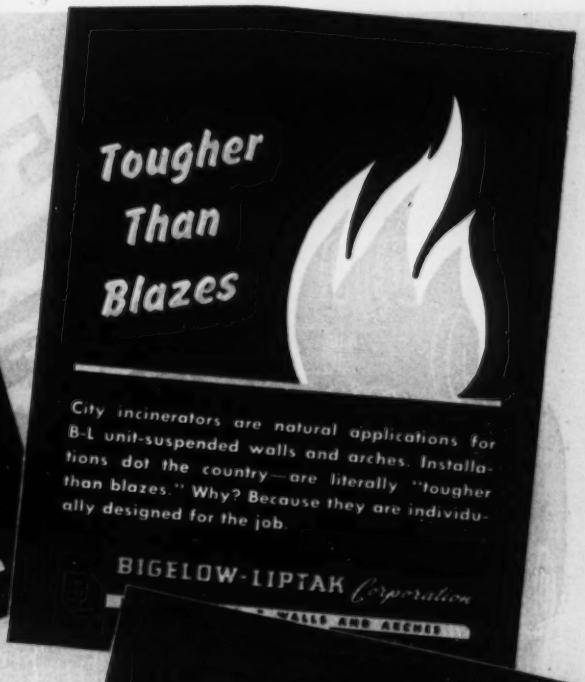
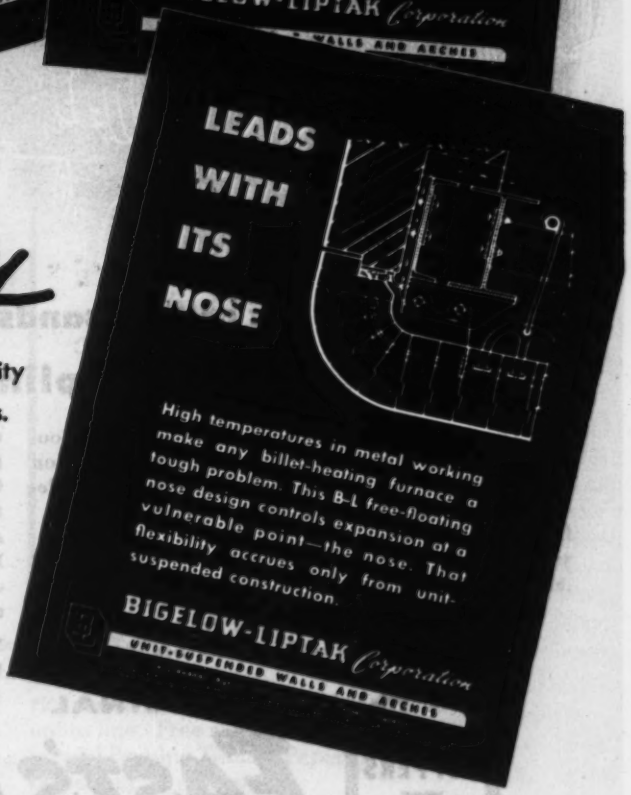
Reproduction
CLOTH

Your Peerless distributor will be glad to supply samples of Peerless Cloth to test in your own plant. Call him, or mail the coupon at left.


King Size
BOILERS
Big boilers for utilities and general manufacturing? B-L's tube supported wall design and Texad* finishes eliminate enclosure structural steel and steel plate casings. That saves plenty on the original cost! Performance? Better than ever!
BIGELOW-LIPTAK Corporation
UNIT-SUSPENDED WALLS AND ARCHES


Tougher Than Blazes
City incinerators are natural applications for B-L unit-suspended walls and arches. Installations dot the country—are literally "tougher than blazes." Why? Because they are individually designed for the job.
BIGELOW-LIPTAK Corporation


LEADS WITH ITS NOSE
High temperatures in metal working make any billet-heating furnace a tough problem. This B-L free-floating nose design controls expansion at a vulnerable point—the nose. That flexibility accrues only from unit-suspended construction.
BIGELOW-LIPTAK Corporation
UNIT-SUSPENDED WALLS AND ARCHES

Versatility

You'll find that versatility is an inherent quality in B-L's design for furnace walls and arches. Thermal problems—erosion hazards—desired end results—are factors that govern the final design. That's why you see so many B-L installations through industry. After all, they provide long, dependable service at a low, low cost. More information? Write today.

*REGISTERED TRADE MARK

BIGELOW-LIPTAK Corporation

AND BIGELOW-LIPTAK EXPORT CORPORATION
2550 WEST GRAND BOULEVARD, DETROIT 8, MICHIGAN

UNIT-SUSPENDED WALLS AND ARCHES

In Canada: BIGELOW-LIPTAK OF CANADA, LTD., *Toronto, Ontario*

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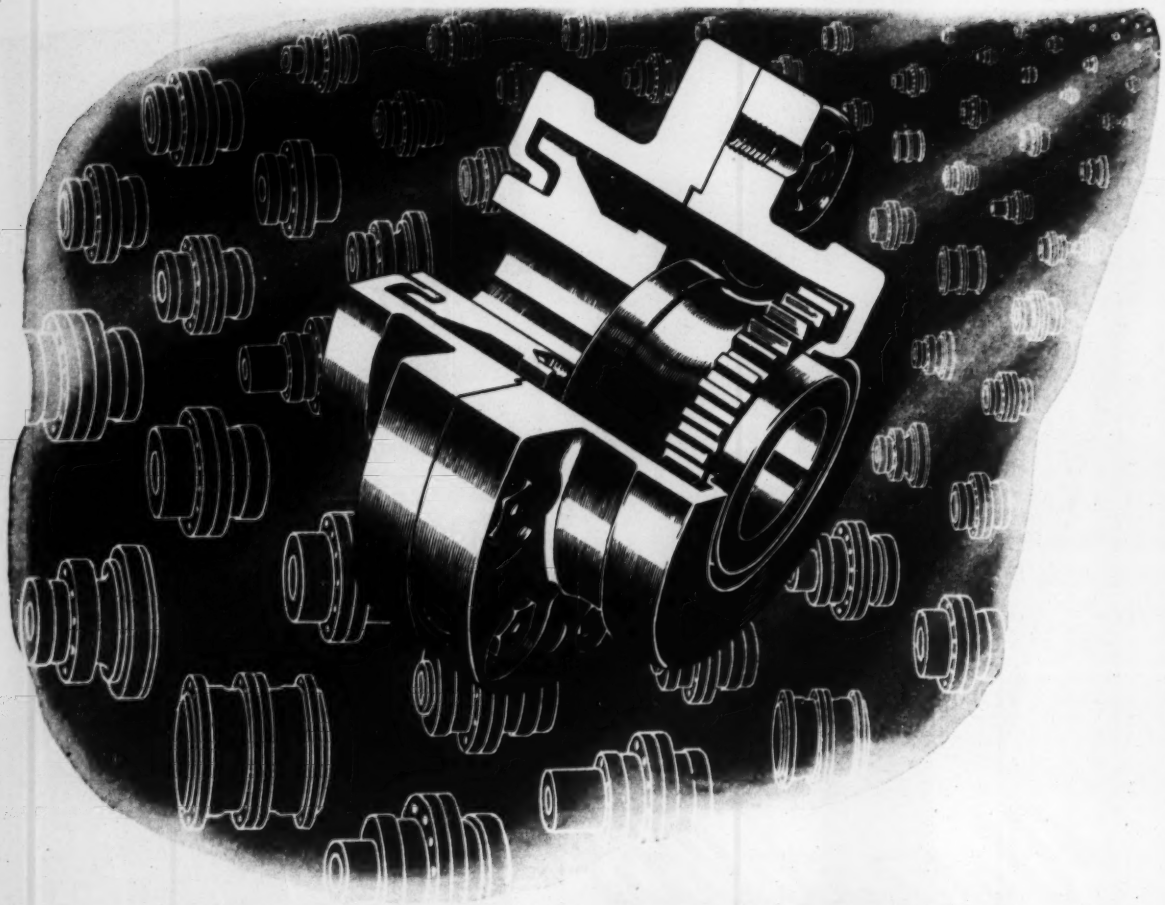

Hundreds of thousands of installations prove . . .

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There's no stronger endorsement of Fast's Couplings than the close to three-quarter million Couplings installed in the 33 years since their design revolutionized the power coupling business!

Trouble-free performance that saves down-time, maintenance, and money led to that record. And, whatever your coupling applications, it's a guarantee of what *you* can expect from Fast's! Fast's Couplings give you *rugged construction* . . . because their original design has been maintained without basic change or sacrifice in size or materials. Fast's Couplings give you *lowest cost per year* . . . because they usually outlast the equipment they connect. And Fast's Couplings give you the benefit of Koppers *free engineering service* . . . assuring you of the right coupling for any job and the right solutions to tough coupling problems.

Write today for full details to KOPPERS COMPANY, INC., *Fast's Coupling Dept.*, 360 Scott St., Baltimore 3, Maryland.

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THE ORIGINAL

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METAL PRODUCTS DIVISION • KOPPERS COMPANY, INC. • BALTIMORE, MD. This Koppers Division also supplies industry with American Hammered Industrial Piston and Sealing Rings, Koppers-Elex Electrostatic Precipitators, Aeromaster Fans and Gas Apparatus.

Engineered Products Sold with *Service*

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Gentlemen: Send me a Fast's Catalog giving detailed descriptions, engineering drawings, capacity tables and photographs.

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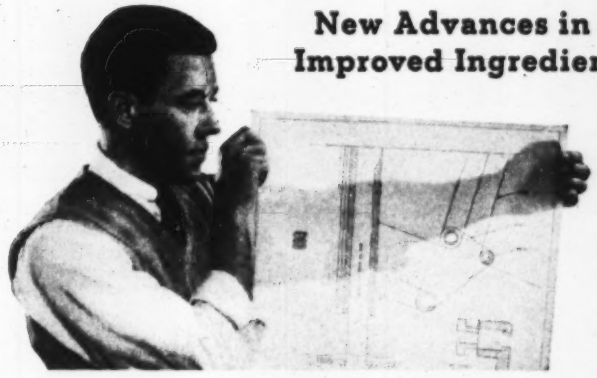
Tracing Papers and Cloths!

New Advances in Manufacturing Techniques, Plus Improved Ingredients, Bring You Important Benefits!



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1. Improved Translucency. More translucent than ever because of an improved transparentizing agent and technique of application.
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4. Easier Erasures. Less danger of damaging surfaces by even repeated erasures.
5. Minimum Leaching. Improved appearance of prints because papers will retain translucency even where drafting tape has been used.

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Just mail the coupon together with one dollar, and you will receive, in return, a 5-yard, 36-inch roll of our leading, all-purpose medium weight tracing paper. Try the paper—the superior results you obtain will be typical of the entire line. Free sample sheets of the new, improved Bruning Tracing Papers and Cloths will be sent upon request.

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Enclosed find $1.00. Please send me 5-yard, 36-inch roll of your new, improved tracing paper at no further cost to me.

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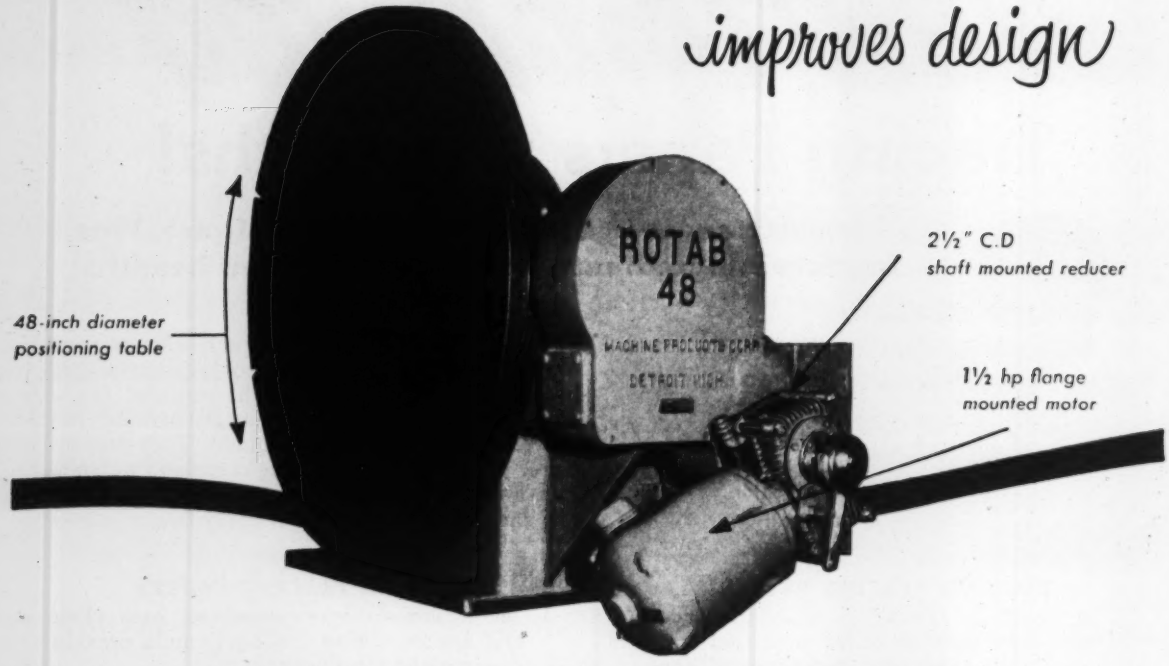
ROTAB - too - improves design



WITH HIGH CAPACITY, SPACE AND WEIGHT SAVING CONE-DRIVE SHAFT MOUNTED SPEED REDUCERS

Yes, Cone-Drive shaft mounted speed reducers save weight and simplify design because of their unique double-enveloping worm gears. Three standard sizes currently available from stock, 2, 2½ and 3 inch center distance, in pinion under, pinion over or vertical shaft models enable you to pick the right reducer for your application. Standard reduction ratios range from 5:1 to 60:1 with additional speed reductions readily available when the motor is connected to the input shaft with vee belts or pulleys.

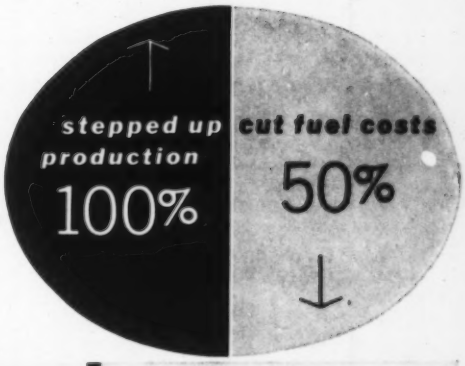
Machine Products Corp., Detroit, improved its 36 and 48-inch diameter Rotab precision positioning tables with motorized Cone-Drive shaft mounted speed reducers. These were added to the two Cone-Drive gearsets already used on the Rotab to give fast, smooth table tilting and eliminate operator fatigue when the table is operated continuously for precision checking or machining.

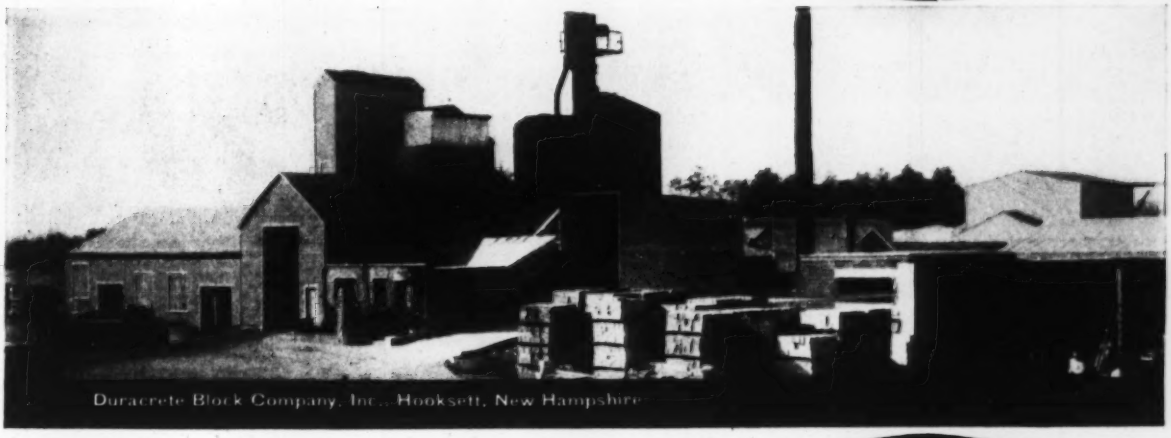
You too, can improve your product's performance, cut manufacturing costs, simplify maintenance and streamline its appearance with a space saving Cone-Drive shaft mounted speed reducer, motorized or standard drive. For motorizing, a bell housing accommodates standard NEMA C-type flanged motors.

COMPLETE ENGINEERING DETAILS ARE AVAILABLE IN BULLETIN CD-323. IT'S FREE FOR THE ASKING.

CONE-DRIVE GEARS
Division, Michigan Tool Company
DOUBLE ENVELOPING GEAR SETS & SPEED REDUCERS
7171 E. McNichols Road • Detroit 12, Michigan

How a KEWANEE Reserve Plus Rated boiler...




Duracrete Block Company, Inc., Hooksett, New Hampshire

■ Anyone would find it difficult to prove to Dante V. Donati, Manchester, New Hampshire, that Kewanee Reserve Plus Rated Boilers do not pay dividends. That's because he discovered it the hard way. First, he bought an ordinary boiler for his plant at the Duracrete Block Company. He operated it one year, and then . . . but let him tell the story—

"We installed an ordinary boiler and found it to be inadequate. We then purchased a Kewanee Unit. Our production was stepped up more than 100% . . . with fuel costs cut in half. Maintenance cost is extremely low. The quality of our product has improved because of lower moisture content due to ample steam for processing."

Judging from Mr. Donati's experience it just makes sense that it's money in the bank to follow the Kewanee Reserve Plus Rating Plan in selecting a boiler. So when you choose a boiler, know these important facts:

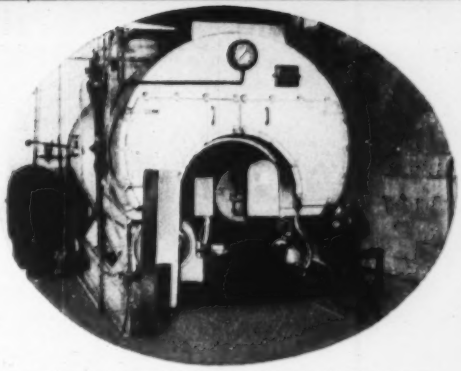
1—*Boiler rating must be based on nominal capacity, not maximum capacity;*

2—*Boilers must have sufficient built-in reserve to meet changing demands;*

3—*Boilers must have sufficient capacity to operate at "cruising speed," not maximum speed at all times;*

4—*Like examples must be considered in comparing boilers. Don't be confused by vague technical claims.*

Choose Kewanee and cut fuel costs—lower maintenance—reduce breakdowns—get longer boiler life.



Here is No. 85-60 Kewanee Oil Fired Boiler-Burner Unit installed at the Duracrete Block Company.

KEWANEE BOILERS
KEWANEE-ROSS CORPORATION, Kewanee, Illinois
Division of American Radiator & Standard Sanitary Corporation
Serving home and industry · American-Standard · American Blower
Church Seats & Wall Tile · Detroit Controls · Kewanee Boilers
Ross Exchangers · Sunbeam Air Conditioners
YOU can depend on KEWANEE engineering

Depend on LADISH

To Meet All Your Fittings Needs With an Unsurpassed Range of Sizes and Materials

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TO MARK PROGRESS

1 BUTT WELDING FITTINGS

2 A.S.A. FORGED FLANGES

3 FORGED SCREWED OR SOCKET WELDING FITTINGS

4 T.E.M.A. HUB & RING FLANGES

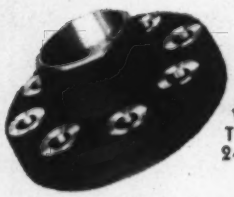
5 LONG WELDING NECKS

6 LARGE DIAMETER FLANGES AND RINGS

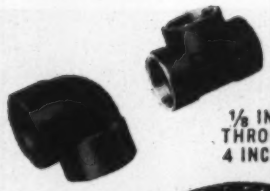
Available in...

Complete Service . . .

½ INCH THROUGH 42 INCHES



½ INCH THROUGH 24 INCHES



⅛ INCH THROUGH 4 INCHES

6 INCHES THROUGH 46 INCHES

½ INCH THROUGH 24 INCHES

UP THROUGH 20 FEET O.D.

CARBON, STAINLESS AND ALLOY STEELS, ALUMINUM, NICKEL AND OTHER FERROUS AND NON-FERROUS METALS

To Meet Your Entire Fittings Needs with a Line Complete In All 6 Major Types

For dependable service that results from an ideal combination of broad line and ample stock . . . specify and buy LADISH . . . the Controlled Quality line that offers a complete range of sizes, types, weights, pressure ratings and materials needed for virtually any piping installation. Your local Ladish distributor's ample stock is backed by complete factory inventories to keep your piping jobs on schedule. So, for *complete service* in fittings . . . specify and buy LADISH.

For your new 304-page Ladish Fittings Catalog, No. 55 contact your Authorized Ladish Distributor, your local Ladish District Office, or write to Ladish Co., Dept. ME, Cudahy, Wis.

THE COMPLETE *Controlled Quality* FITTINGS LINE
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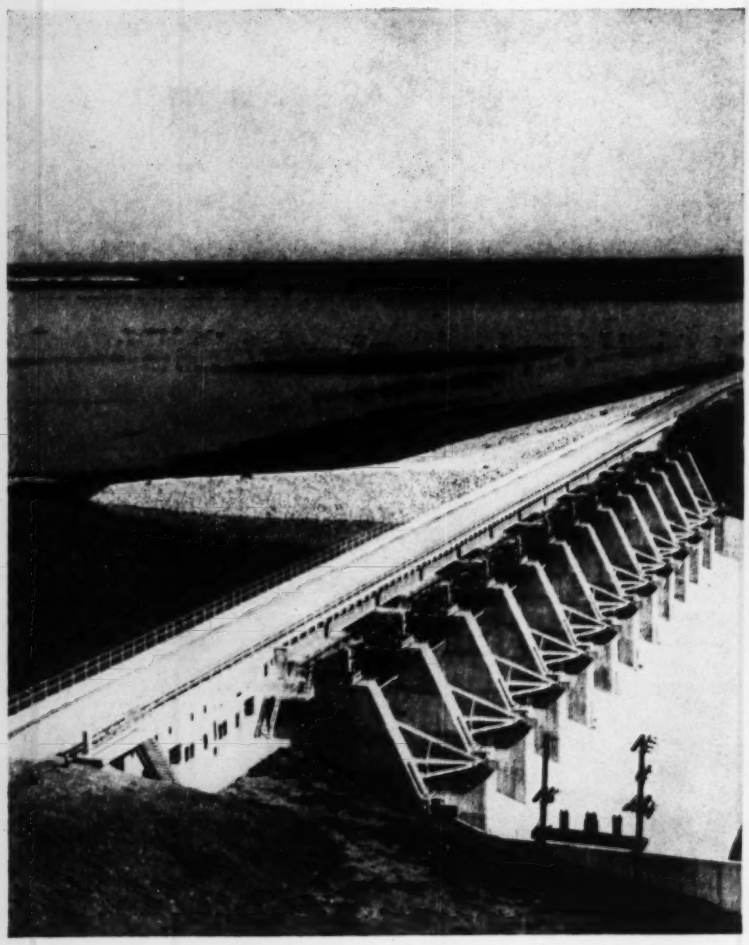
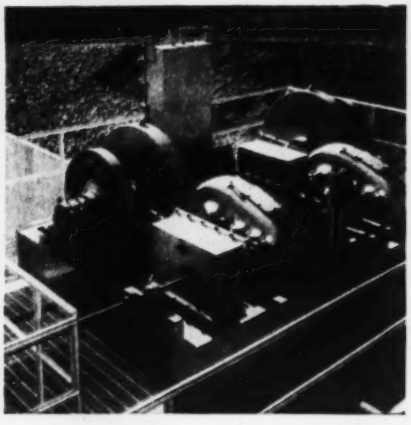


Gate drives at Lavon Dam include Link-Belt parallel shaft and worm gear drives as well as roller bearing pillow blocks. Caldwell Foundry & Machine Co., Birmingham, Ala., furnished the twelve hoists.



At Lavon Dam, Link-Belt enclosed gear drives and bearings help

provide flood protection and water conservation for north Texas

TO control the whims of the Trinity River, the U. S. Army Corps of Engineers is building a network of dams. One of these—Lavon Dam across the Trinity's East Fork—provides water supply for ten north Texas towns and protects 50,000 acres of farmland downstream from floods.

Power to raise and lower 40 x 28 ft. gates in Lavon's spillway section is supplied through Link-Belt enclosed gear drives and roller bearings. This efficient power transmission equipment was selected for its proved ability to maintain year in, year out dependability under all types of atmospheric conditions.

Next time you're faced with a drive or conveying job, get in touch with the Link-Belt office near you. Ask for a copy of the new Link-Belt Standard Products Catalog No. 950. Or you can get this 340-page book on power transmission, conveying and elevating products by writing Link-Belt Company, Dept. AV, 307 N. Michigan Ave., Chicago 1, Ill.

LINK-BELT

One source . . . one responsibility for materials handling and power transmission machinery

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 13 834

International Harvester's New McCormick 141 Self-Propelled Harvester-Thresher

Quality FELT

HELPS PROTECT PERFORMANCE

Modern automotive equipment—airplanes, cars, trucks, tractors, Diesel and marine engines, motorcycles—use felt to protect many vital parts. This versatile and essential industrial material serves to seal out dust, dirt, water, seal in lubricants. Many ball bearings have felt seals which enable the bearing to serve reliably for a lifetime with the lubricant originally installed. Other uses of felt include sound and thermal insulation, vibration control, weather stripping, window channels, lubrication wicks . . . American supplies felt in sheets, strips, wicking, and in parts cut precisely to your blueprints, ready to install. There are many types of felt; for maximum satisfaction, consult American for confidential collaboration on designs and specifications for your various applications. Write on your company letterhead for S.A.E. Felt Standards, including samples and specifications.

American Felt Company

TRADE MARK

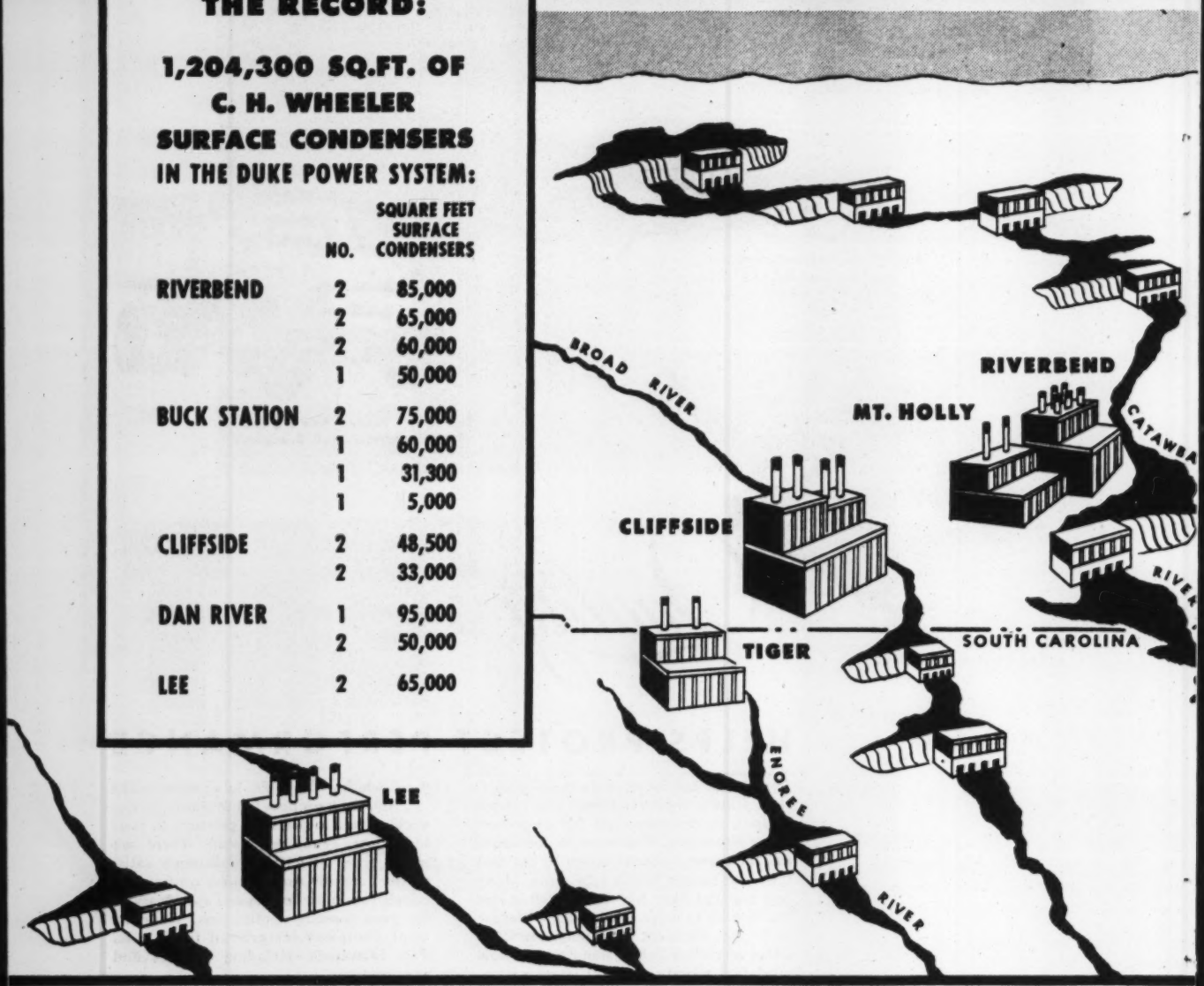
GENERAL OFFICES: 50 GLENVILLE ROAD, GLENVILLE, CONN.
SALES OFFICES: New York, Boston, Chicago, Detroit, Cleveland, Rochester, Philadelphia, St. Louis, Atlanta, Dallas, San Francisco, Los Angeles, Portland, Seattle, Montreal. PLANTS: Glenville, Conn.; Franklin, Mass.; Newburgh, N. Y.; Detroit, Mich.; Westerly, R. I.
ENGINEERING AND RESEARCH LABORATORIES: Glenville, Conn

DUKE POWER *picks*

THE RECORD:

1,204,300 SQ.FT. OF C. H. WHEELER SURFACE CONDENSERS IN THE DUKE POWER SYSTEM:

	NO.	SQUARE FEET SURFACE CONDENSERS
RIVERBEND	2	85,000
	2	65,000
	2	60,000
	1	50,000
BUCK STATION	2	75,000
	1	60,000
	1	31,300
	1	5,000
CLIFFSIDE	2	48,500
	2	33,000
DAN RIVER	1	95,000
	2	50,000
LEE	2	65,000

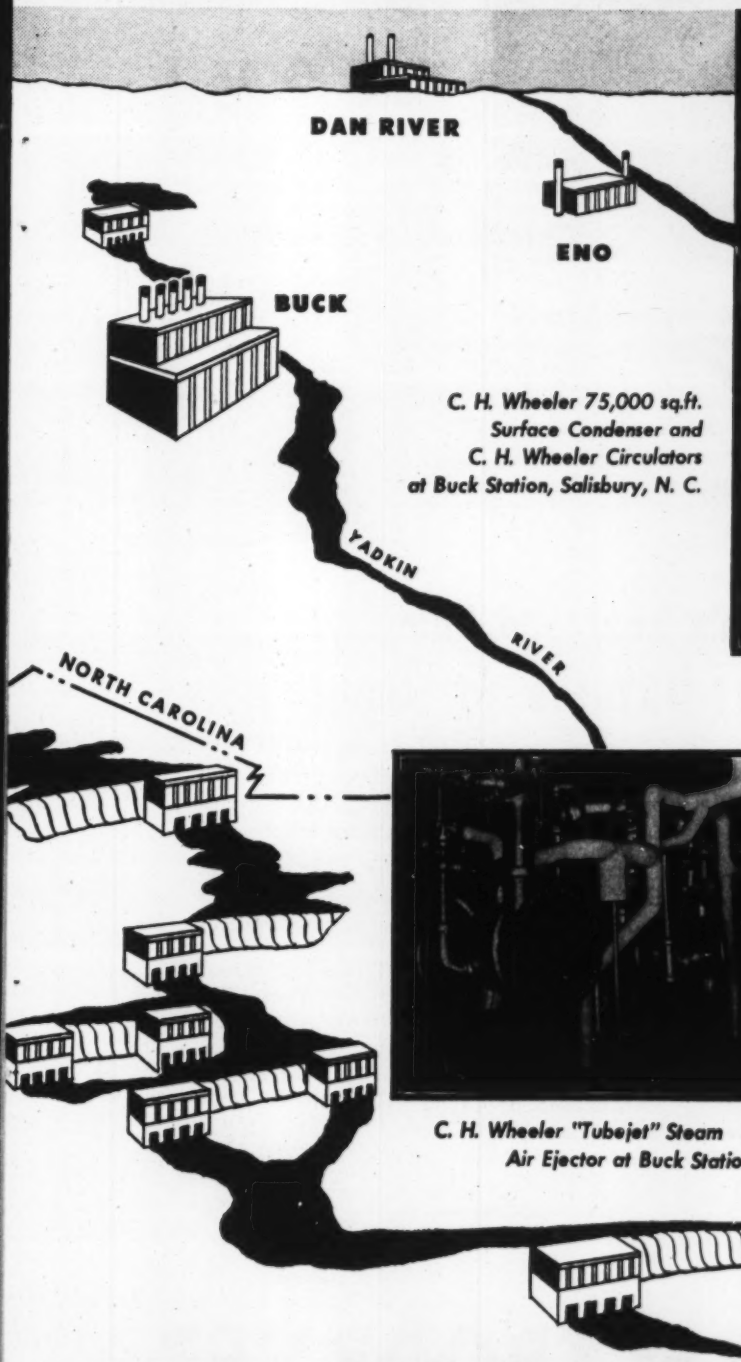


C. H. Wheeler Steam Condensers, Air Ejectors, Circulating and Condensate Pumps are tried and trusted equipment in every new steam power generating station that Duke Power has built. Photos show some of the latest installations in the new Buck Station where five C. H. Wheeler Surface Condensers are installed, ranging in size from a 5000 sq.ft. house turbine unit to a 75,000 sq.ft. unit. All other steam stations on the Duke system are completely equipped by C. H. Wheeler. This equipment is designed to strike a sound balance between first cost, operating efficiency and maintenance costs.

There's progressiveness in C. H. Wheeler engineering that matches the expansion plans of a great utility like Duke Power. A new 95,000 sq.ft. Surface Condenser Unit and auxiliaries is now being manufactured for Dan River Station.

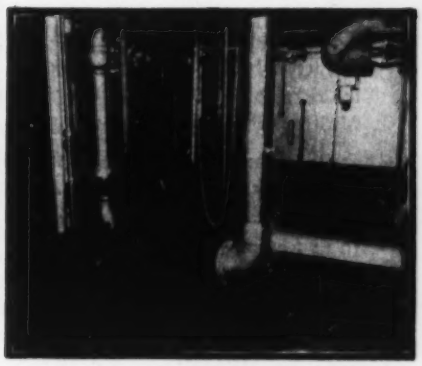
The art of condensing steam and producing vacuum for the prime movers of industry has the seasoning of 50 years of development at C. H. Wheeler. You can find no richer experience . . . no greater vision for the future of steam power generation . . . than at C. H. Wheeler of Philadelphia. . . . ***HOW MAY WE HELP YOU?***

C. H. WHEELER
STEAM CONDENSERS—AIR EJECTORS
CIRCULATING AND CONDENSATE PUMPS



C. H. Wheeler 75,000 sq.ft. Surface Condenser and C. H. Wheeler Circulators at Buck Station, Salisbury, N. C.

C. H. Wheeler "Tubejet" Steam Air Ejector at Buck Station



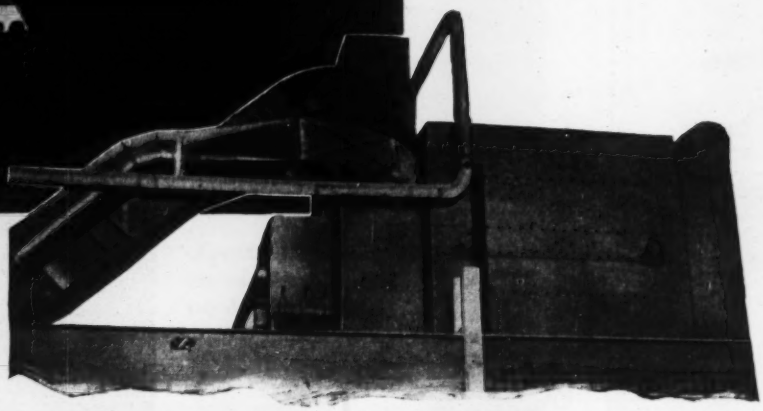
C. H. Wheeler 5-stage Condensate Pumps Operating on a Split Cycle System with a balancing standpipe between stages

C. H. WHEELER *of Philadelphia*

C. H. WHEELER MANUFACTURING CO., 19th & LEHIGH, PHILADELPHIA 32, PENNA.

Steam Condensers • Centrifugal, Axial and Mixed Flow Pumps • Steam Jet Ejectors • Vacuum Refrigeration • Air
High Vacuum Process Equipment • Micro Particle Reduction Mills • Marine Condensers and Ejectors • Deck Machinery

◀ Addressograph-Multigraph Corporation, Euclid, Ohio, tests machines and supplies under extremes of temperature and humidity in this room. Thus, they can assure users that machines will function properly wherever in the world they are sold.



CH-type Lectrodryer capable of reducing relative humidity to as low as 15% in Addressograph-Multigraph's 2100 cubic foot test room. ▶

Duplicating Africa's heat and humidity or Arabia's desert DRYness any time!

Temperature can be adjusted up to 100° F. Relative humidity can be varied anywhere from 15% to 95% in this Addressograph-Multigraph Corporation test room.

Steam heat and steam jets supply high temperatures and humidities. A Lectrodryer* supplies the desert DRY relative humidities to as low as 15%.

Lectrodryers are providing similar DRYness in industrial storage space, around process machinery and wherever air or other gases must be DRY. They can reduce dewpoints below −100° F . . . drop relative humidities below 10% . . . handle pressures up to 6,000 psi. Organic liquids can be dried to a moisture content below 3 or 4 parts per million.

Give us the particulars on what you want DRY. Our engineers will study those facts and recommend a type and size Lectrodryer to do the job.

Data Available: Write for *Because Moisture Isn't Pink,* a booklet describing Lectrodryers and telling what jobs they are performing in industry. Pittsburgh Lectrodryer Corporation, 335 32nd Street, Pittsburgh 30, Pennsylvania.

In England: Birlec, Limited, Tyburn Road, Erdington, Birmingham.
In France: Stein et Roubaix, 24 Rue Erlanger, Paris XVI.
In Belgium: S. A. Belge Stein et Roubaix, 320 Rue du Moulin, Bressoux-Liege.

LECTRODRYERS DRY WITH ACTIVATED ALUMINAS

LECTRODRYER

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ALL FORGED STEEL

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Powering equipment at the Dana Warp Mills meant putting compact and dependable drive units into cramped quarters. To meet space limitations, designers carefully selected gearmotors with minimum size and definite servicing advantages . . . they specified Life-Line Gearmotors.

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For detailed information, write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-07323

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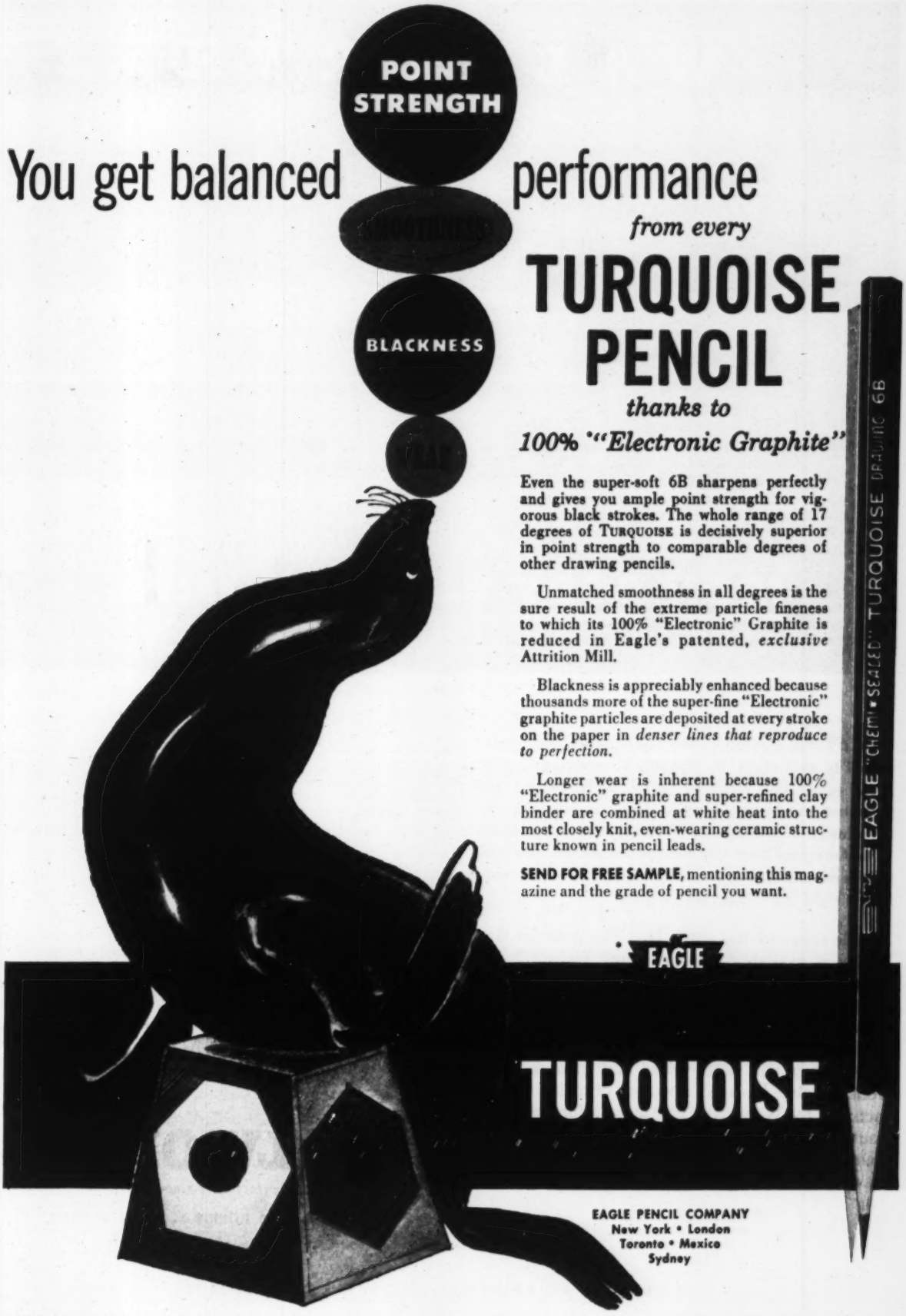

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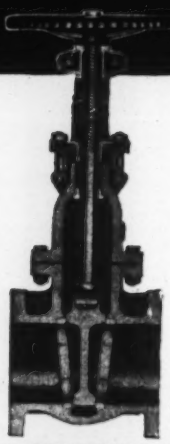

Walworth No. 726F OS&Y (Outside Screw and Yoke) Iron Body Wedge Gate Valve. OS&Y valves are recommended for services where it is desirable that the line fluid does not come in contact with the stem threads. Note the swing-type gland-eye-bolts for easy repacking. Sizes 2 to 30 inches.

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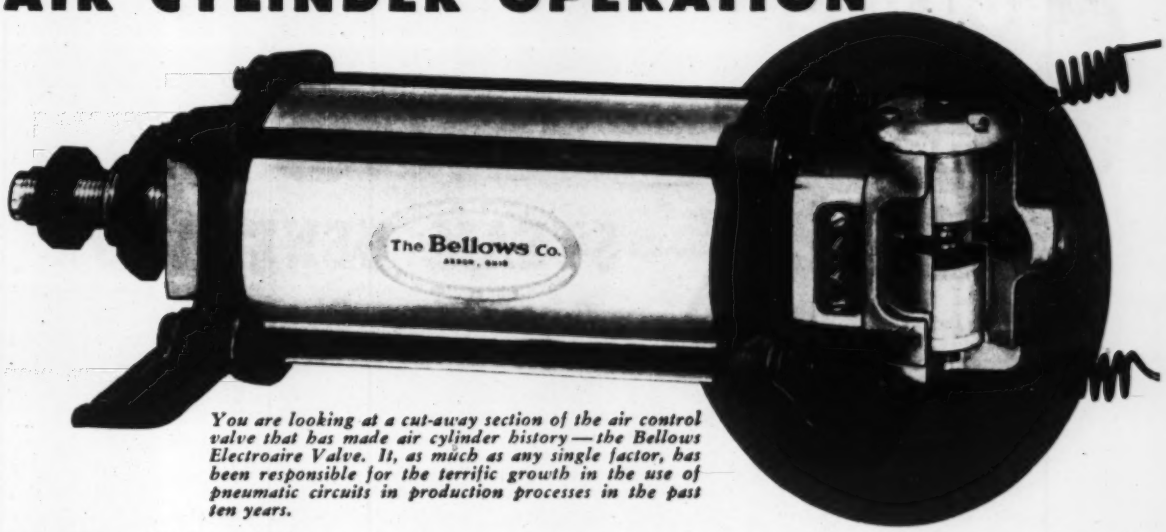

You are looking at a cut-away section of the air control valve that has made air cylinder history — the Bellows Electroaire Valve. It, as much as any single factor, has been responsible for the terrific growth in the use of pneumatic circuits in production processes in the past ten years.

Why? - First of all — it is a complete air control unit. Not only does it direct the high pressure air to the desired cylinder port *instantly, without lag,* but it regulates and controls the speed of the air cylinder piston.

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And finally — the Electroaire Valve is durable. Over a quarter of a million are in everyday use. Records of 30,000,000, 40,000,000 even 50,000,000 cycles without repairs of any kind are common.

Of course, the Electroaire Valve is a built-in feature of all electrically-controlled Bellows Air Motors, but it is equally suitable for use with any conventional air cylinder up to bores of 4½" - 5".

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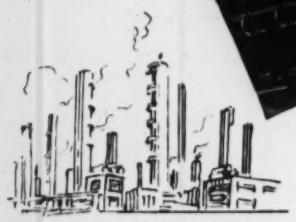
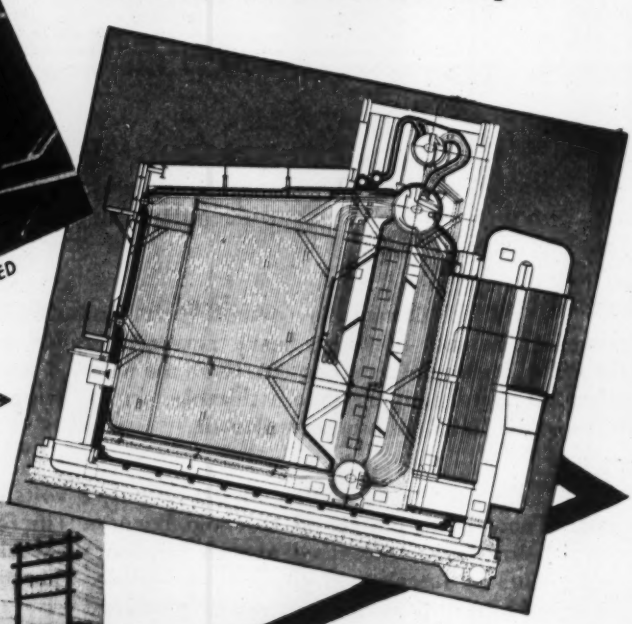
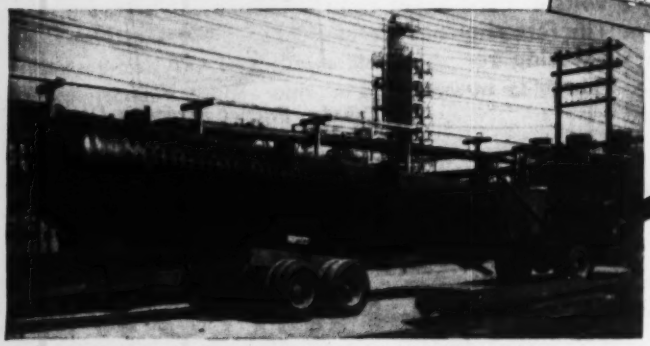


RIGHT → LONGITUDINAL SECTION THROUGH THE UNIT.





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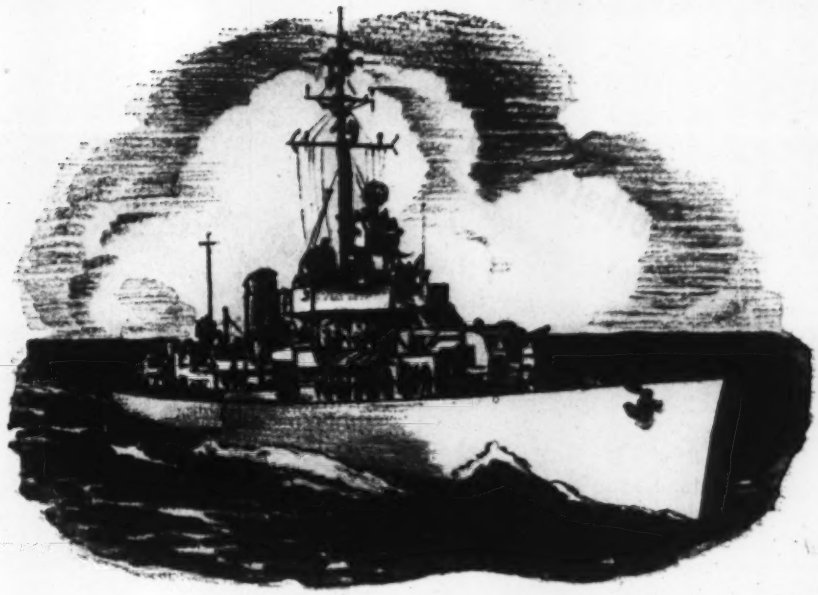
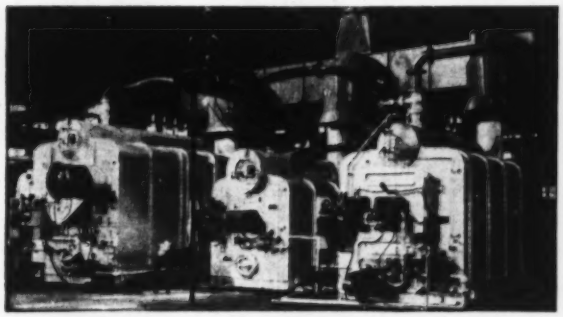


"the Shakedown Cruise"



Each KEYSTONE Steam Generator is FACTORY FIRE TESTED with the fuel and burner to be used

Before the United States Navy considers a ship as ready to take her place with the fleet, she is given a **shakedown** cruise. This cruise allows the Navy to check the ship from stem to stern and to make sure each working part is functioning properly. Exhaustive tests such as these assure the Navy that its ships can meet any emergency.

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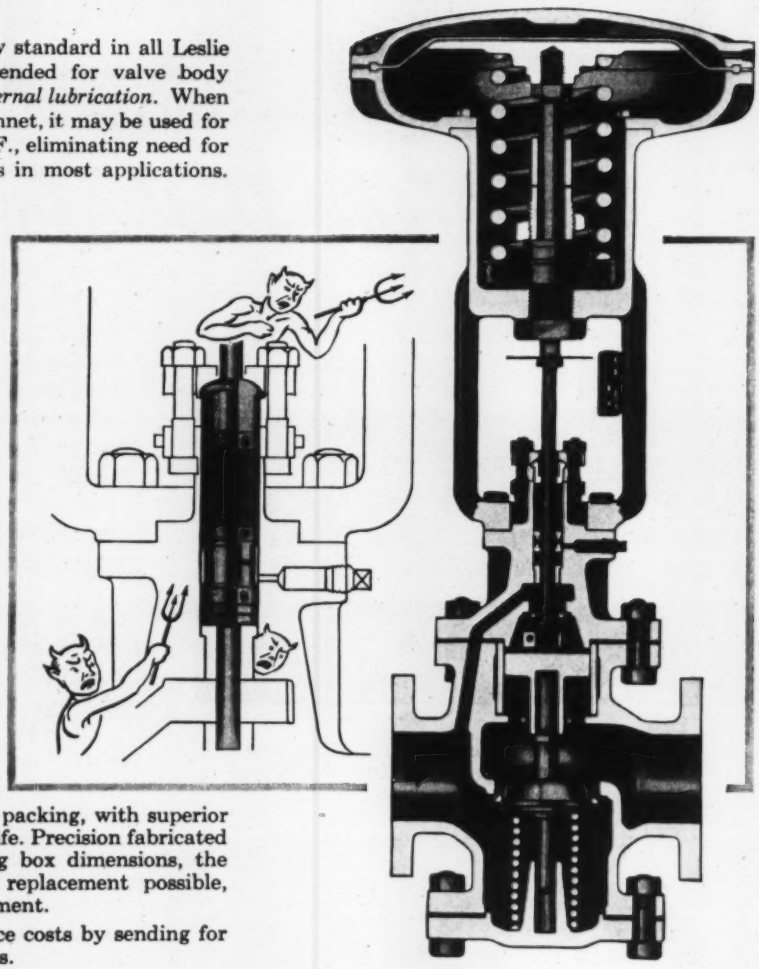
The new Leslie Lubrisoft® Packing now standard in all Leslie Diaphragm Control Valves is recommended for valve body temperatures up to 500° F. *without external lubrication.* When used with the Leslie thermo-isolating bonnet, it may be used for valve body temperatures up to 1050° F., eliminating need for external lubricators and isolating valves in most applications.



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Each of the several types of Lubrisoft split ring packing is specifically designed to maintain the low-friction stem seal against one or more of these deteriorative service conditions:

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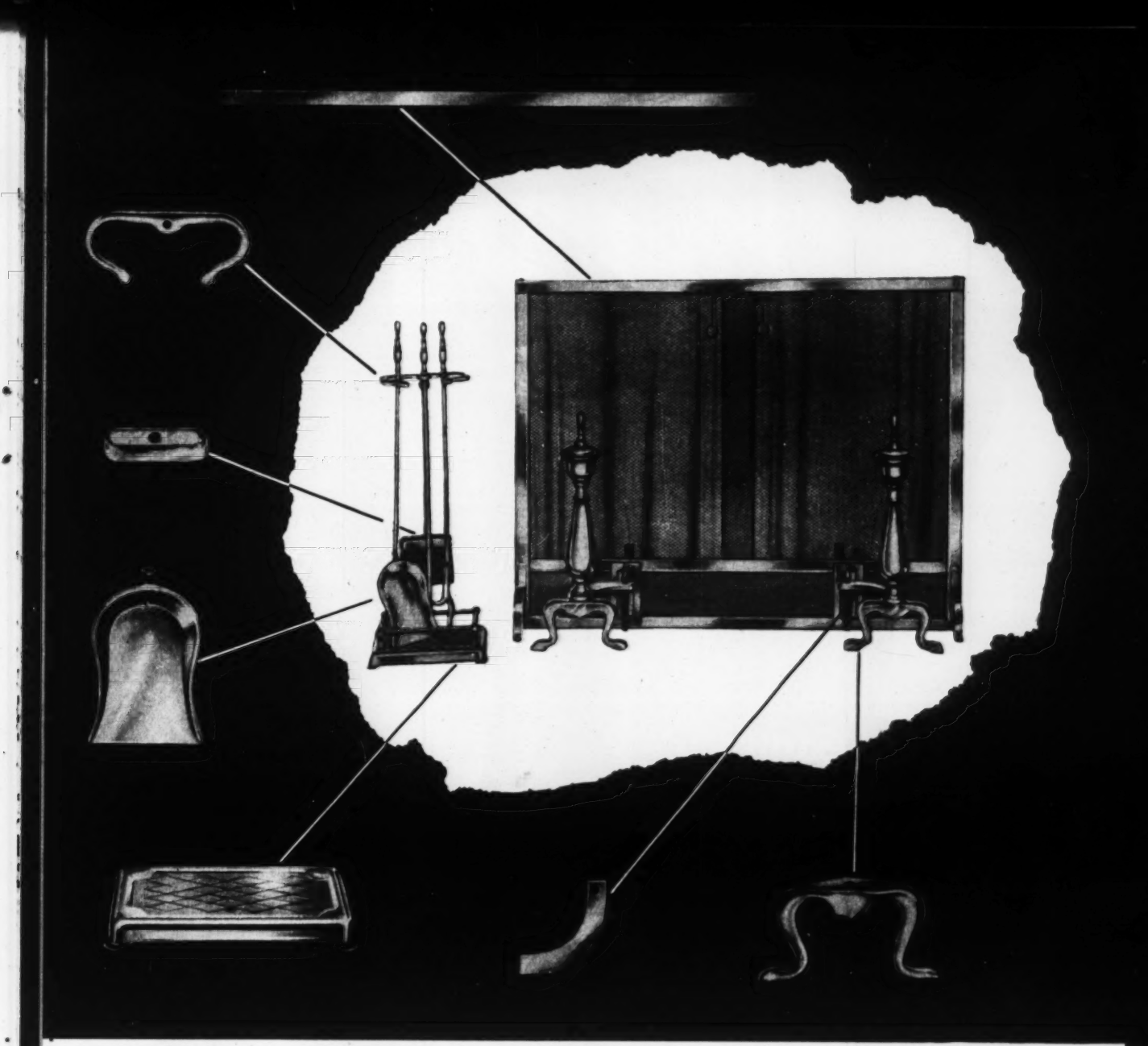

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New kind of brass called "FORMBRITE" cuts finishing costs

The bright, lustrous finish you see on this fireplace equipment — made of FORMBRITE* sheet metal — is the result of a simple color buff that took about half the time previously required. FORMBRITE's appearance after buffing speaks for itself.

FORMBRITE's superfine grain structure provides a surface far superior to ordinary drawing brasses. In every case, it's meant important savings in finishing costs... *and* improved product quality.

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Revere Extruded Shapes help increase ELECTRIC GENERATOR OUTPUT

(perhaps you, too, could use our shapes to your advantage)

Model section of G.E. direct-cooled rotor for turbine-generator. Note intake scoop at left front, hollow copper conductors of extruded shapes, in center, exhaust outlet at right rear.

Insert shows typical extruded shapes after milling by G.E. to provide circulation of hydrogen throughout the field coils.

Winding temperatures are an important limitation upon the output of electric utility generators. They must be kept within safe limits to avoid damaging the insulation. Hence all generators have some method of cooling. Conventionally, the heat passes from the copper conductors in the rotor, through the insulation (which presents a formidable barrier to heat transfer) to the steel parts of the rotor body, and air or hydrogen is pumped through and around the rotor. It was realized long ago that more effective cooling could be obtained if some way could be found to remove the heat directly from the rotor coils.

Some years ago generator engineers of the General Electric Company, Schenectady, New York, proposed making each turn of the rotor coils of two copper extruded shapes; one a channel, the other comb-like. Fitted together, they would make hollow passages for the hydrogen, which would be taken in through scoops on the surface of the rotor, and exhausted through outlets some distance away, also on the rotor surface. In that way, the rotor could be quite uniformly and more effectively cooled throughout its length, and output greatly increased in relation to the physical dimensions of the generator.

An important problem was found in the extruded shapes. Design requirements had to be adjusted to the opportunities and practicalities of the extrusion process. Today these copper shapes, 20 feet long, drawn and finished to strict specifications as to dimensions and straightness, are making it possible to remove four times as much heat as conventional systems, and to double the generator output with no increase in size... For full information on extruded shapes, see the nearest Revere Sales Office.

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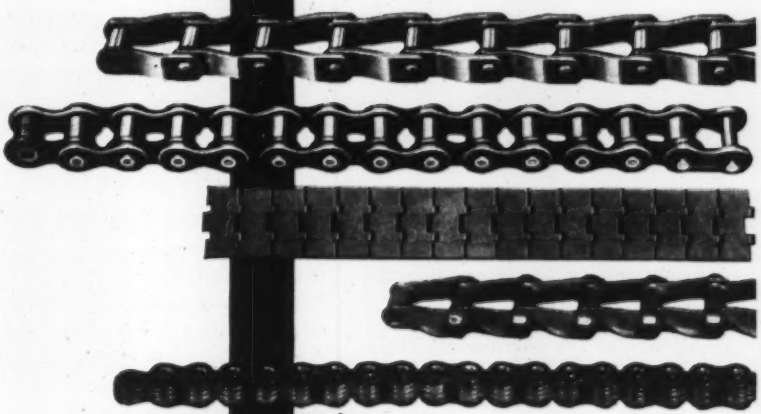

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Ductile Iron Crankshafts cast at The Cooper-Bessemer Corporation's Mount Vernon, Ohio, foundry and machined at its plant in Grove City, Pa., for GMX-4 engines. The first of this model equipped with a ductile iron shaft was shipped in June, 1953. Cooper-Bessemer initiated development work on high test irons for crankshafts in 1935. Some mechanical properties of ductile iron, compared with those of forged steel . . . traditionally used for crankshafts . . . are shown below.

HIGH

Mechanical Properties, Wear Resistance and Castability make

Comparative Properties		
	Ductile Iron	**Forged Steel**
Tensile Strength	79,200 psi	80,100 psi.
Endurance Limit (Smooth bar)	31,500 "	35,000 "
Endurance Limit (Notched bar)	20,750 "	17,800 "
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Brinell Hardness	220	170

Ductile Iron an Ideal Crankshaft Material

Wouldn't you rather *cast* a crankshaft than block forge it?

Wouldn't your costs tumble for every unit with bearings cored out, counter-weights molded on, and the entire piece cast within tolerances that reduce machining to a minimum?

And wouldn't the excellent castability, toughness, stiffness and machinability of ductile iron bring you advantages like those brought to Cooper-Bessemer?

Glance at the tabulation. You'll see a few reasons why Cooper-Bessemer concluded that ductile iron provides the best combination of properties offered by any material they have tested for crankshafts.

The damping capacity of ductile iron is excellent . . . less than that of gray iron, but far superior to steel. Especially valuable in crankshafts is the relatively high "notched endurance limit" of ductile iron. And another outstanding property is its resistance to mechanical wear... under lubricated or non-lubricated conditions.

Combining the *process advantages* of cast iron and the *product advantages* of cast steel, ductile iron has, actually, many applications.

Send us details of your prospective uses, so that we may offer a list of sources from some 100 authorized foundries now producing ductile iron under patent licenses. Request a list of available publications on ductile iron . . . mail the coupon now.

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SEPTEMBER 1954

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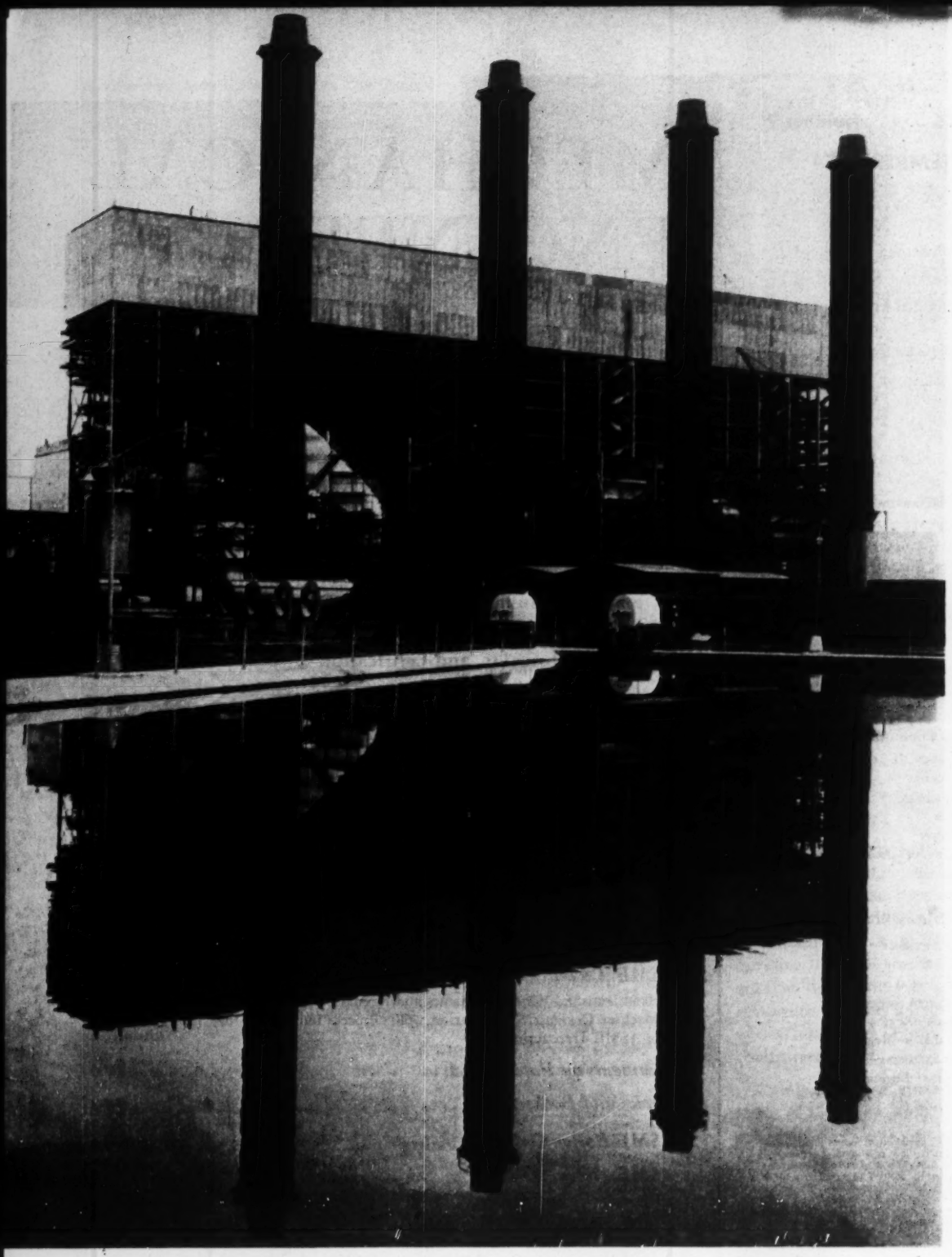

Pittsburg Plant of the Pacific Gas and Electric Company . . .

. . . is an $80 million installation now nearing completion near Pittsburg, Calif. Its 600,000-kw capacity makes it the largest steam-electric generating plant west of the Mississippi River. This study in reflections is also a study in smoke stacks and their nozzles. Unusual in western installations, the 12-ft nozzles which top the four 212-ft-high stacks of the Pittsburg plant act much like garden-hose nozzles, channeling the smoke into a narrow forceful flow. The smoke, therefore, is forced high into the air and then dissipated, instead of settling into the lower atmosphere. Photo courtesy of *Bechtel Briefs*, June, 1954.

Editorial

MECHANICAL ENGINEERING

September, 1954, Vol. 76, No. 9 . George A. Stetson, *Editor*

From Watt to What?

When The American Society of Mechanical Engineers was founded in 1880, the steam engine was barely one hundred years old. Although it was not the only element on which our present era of industrial civilization was based, Watt's steam engine—a prime mover practically independent of geographical location and the vagaries of the weather and applicable in stationary and mobile units alike—was of the utmost importance and significance.

Prior to Watt's time, with the exception of pumping by means of the crude engines of Savery and Newcomen, men were forced to rely on wind, water, and animal power to supplement their own physical energy. Even the lathe and the sculpturing machines which Watt used in his own private workshop, now preserved complete in the Science Museum at South Kensington, were operated by foot treadles. So it may be said that man's emancipation from back-breaking toil and to a large extent from insufficient and limited production of the necessities of life began with Watt, who thus became, as H. W. Dickinson has asserted, "the virtual founder of the profession of mechanical engineering."

Watt's right to be known as the founder of the profession of mechanical engineering does not rest on the steam engine alone. Collateral developments in which he was associated or which his genius brought into being, also qualify him for that distinction. He was in touch with the scientists of his day, and through him science and the mechanic arts were strongly and forever linked. He discovered, as had also his friend Joseph Black, the latent heat of steam and had determined and plotted the relationship between temperature and pressure of steam and "thereby found the law by which they were governed, sufficiently near for my then purpose." With him began the science of thermodynamics.

Nor must we fail to note another of Watt's qualities that marks him as an engineer. His pumping engines were sold on the basis of the coal they would save, and hence it became necessary for him to test performance and measure fuel consumption which he expressed as the "duty" of the pump. To him we owe the power unit "horsepower"; and its electrical counterpart was called the "watt" in honor of him. Of necessity he was compelled to devise instruments and regulating mechanisms, such as steam gages, the steam-engine indicator, and the centrifugal governor.

Watt and his contemporaries introduced a swift acceleration of change into the economic, social, and political conditions of Western Europe and North America known as the Industrial Revolution. Although today we can agree with Crosby Field that "the engineer removes the need for slavery," there were times and circumstances in the dynamic era which sprang into life with Watt's gift of power that appeared to threaten the best interests of those who eventually reaped the richest harvest of benefits from the abundance and universal availability of cheap power, and to make them slaves, rather than masters, of the machine. Followers of Watt, particularly the mechanical engineers of the twentieth century, have gradually brought order and organization out of the social and economic chaos that characterized the opening decades of the Machine Age by applying sound engineering and humanitarian principles to problems born of change.

The year 1955 will mark the bicentennial of the first steam engine in the New World, a Newcomen engine erected in New Jersey by Josiah Hornblower. It was, of course, soon to be obsolete because of Watt's improvements, but it serves as a reminder of the inevitable consequences to be expected of the dynamic economy which the Industrial Revolution brought about. The benefits of change have accrued to the common men of the Western World in their rapidly growing emancipation from the hazards which nature has imposed on mankind since the dawn of civilization; yet these benefits of change generate their own hazards, such as the delicate dynamic balance they require of social and economic institutions, the essential artificiality of civilization itself, and, in engineering and industry particularly, a rapid obsolescence, the price paid for material progress. Especially is that obsolescence at work in the field of power; and as in the past, so in the future we may expect change.

And so, from Watt to what? Who knows? It is not as yet necessary to predict the decline of heat engines deriving their energy from the combustion of hydrocarbons, even though nuclear-fuel power plants are already in the experimental stage, and experimentation is under way in the uses of solar energy, atomic batteries, and other marvels. But the extrapolation of past experience permits the reasonable expectation of greater engineering achievements, more power for doing man's work in the world, and further progress of the emancipation of mankind.

Titanium Technology in Mid-1954

By H. T. Clark,[1] J. P. Catlin,[2] and W. E. Gregg[3]

Rem-Cru Titanium, Inc., Midland, Pa.

Titanium alloys having excellent strength-weight ratios, good creep and fatigue properties, and a useful temperature range up to 1000 F are being produced commercially in tonnage quantities. Techniques suitable for grinding, machining, welding, and fabricating these alloys are presented.

ALTHOUGH the chemical element titanium was discovered over 160 years ago (before chromium and vanadium and less than 10 years after the discovery of molybdenum and tungsten), it is only within the past 10 years that techniques have been developed which are suitable for its commercial production. Since 1948, however, when titanium was first made commercially available, its production has increased at a more rapid rate than that of any other metal, until today the industry has a capacity of 5000 to 6000 tons per year. In the next 2 years this capacity is expected to increase to over 30,000 tons per year.

The extremely rapid development of titanium as a structural material, particularly in the aircraft and chemical industries, has justified the elaborate and expensive techniques necessary for keeping the metal pure during its production.

The resulting properties of titanium include low density, high strength, good ductility, and excellent corrosion resistance, which combine to give it its greatest value in those applications where a high strength-weight ratio is important.

Titanium Production, Melting, and Processing

Titanium ores include rutile and ilmenite. While rutile (TiO_2) is the easier to process, its availability is limited, with the result that most titanium is produced from the iron-bearing ($FeTiO_3$) ilmenite available in large quantities in many areas in North America including Florida, New York State, and Canada.

Most of the titanium produced to date has been reduced from its ore by the process discovered by Kroll in the late 1930's and developed by the Bureau of Mines in the early 1940's. The major steps in this process include the following:

1 Concentration of the ore to 90 per cent TiO_2.

2 Chlorination of this concentrate in the presence of carbon to form $TiCl_4$, a colorless liquid.

3 Reduction of the $TiCl_4$ with magnesium. This is done at elevated temperature in an inert atmosphere. Titanium sponge and magnesium chloride are the products of this reaction.

4 Removal of the magnesium chloride from the sponge by leaching and/or vacuum distillation. The magnesium chloride then may be reduced to magnesium for recycling.

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The commercially pure titanium from the foregoing process is next crushed and characterized by melting a small sample and measuring its hardness. This hardness value is a measure of the purity of the particular batch and is used to determine into what particular alloy or grade the lot will go.

Since titanium is extremely reactive at high temperatures, particularly above its melting point, and will absorb not only oxygen and nitrogen but also react with all of the common refractories, it must be melted either in a vacuum or in an inert atmosphere. The furnace shown in Fig. 1 has been developed to accomplish this

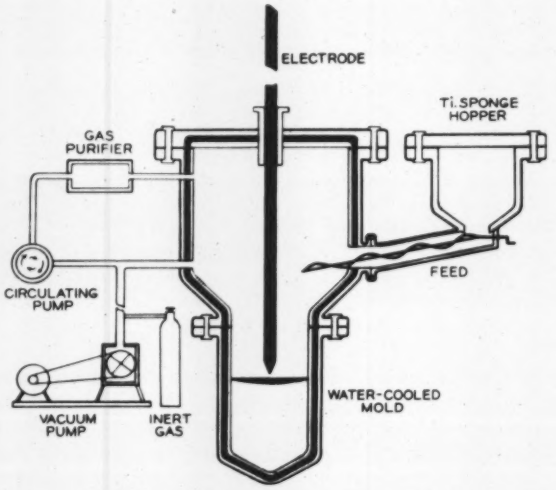

Fig. 1 Schematic of cold-mold titanium melting furnace

required contamination-free melting. It is known as a "cold-mold furnace" and employs the following:

1 A water-jacketed copper mold.

2 Arc melting, using either carbon electrodes, tungsten electrodes, or pressed titanium sponge (consumable electrodes).

3 The whole unit including mold, electrodes, and sponge is contained in a closed system which is evacuated and flushed either with argon or helium.

4 Alloying ingredients are added at this stage.

Table 1 Properties of Various Grades of Titanium

	A-Type			C-Type	
	Unalloyed		Alloy	Plain	Alpha strengthened
Property	A-55 sheet	A-70 sheet	A-110AT sheet	C-110M sheet	C-130AM rolled bar
Ultimate tensile (1000 psi)	75	90	125	130	150
Yield (1000 psi)	65	80	115	120	140
Elongation, per cent	25	20	15	15	20
Reduction in area, per cent	..	..	..	..	40
Proportional limit (1000 psi)	50	65	105	95	105
Bend ductility (T)	1.5	2.0	3.5	2.0	..
Chemical composition	Commercially pure		Ti-5Al-2.5Sn	Ti-8Mn	Ti-4Mn-4Al

They are aluminum, manganese, iron, chromium, tin, and so on.

5 In this process, since the molten sponge freezes immediately on coming in contact with the cold copper mold, the molten titanium is contained essentially in a shell of titanium. The titanium is, therefore, kept free of contamination from the mold materials as well as from the atmospheric contaminants.

After melting, the titanium ingots are conditioned by grinding or turning and then processed into sheet, plate, rod, bar, billet, wire, simple forgings, and tube by practices and equipment similar to those employed in other metal-processing industries. The formability of titanium and its alloys, particularly as applied to fabrication, is discussed in a later section.

Alloy Types

Titanium has two crystal structures; alpha, or hexagonal-close-packed below 1625 F; and beta, or body-centered-cubic between 1625 F and its melting point at 3135 F. By selection of alloying additions, the metallurgist can control the structure of the resulting alloy which, in turn, controls its general properties. Alpha alloys have good strength and contamination resistance both cold and hot, are weldable, but have poorer formability than other types. A-110AT, an alloy containing 5 per cent aluminum and 2.5 per cent tin, is an example of such an alpha alloy.

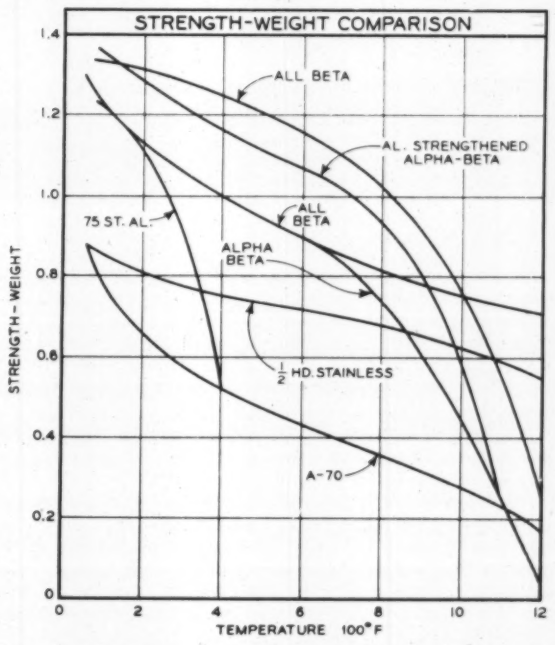

Fig. 2 Comparison of strength-weight properties and strength-temperature relationships of typical titanium alloys

While no beta alloys have been produced commercially, sufficient development work has been done to characterize these alloys as having excellent formability, weldability, and good strength at both room and elevated temperatures. They are more vulnerable to contamination than other alloys and also require large amounts of strategic alloy additions.

Until the recent introduction of the alpha A-110AT alloy, all commercially available alloys belonged to a third class containing both alpha and beta at room and service temperatures. Typical properties include good strength at room and intermediate temperatures, but lower strength at high temperatures, bend ductility between the alpha and beta ones, and excellent forgeability. Their contamination resistance at elevated temperatures is between that of the other two types. C-110M is an example of such an alpha-beta alloy. It contains 8 per cent manganese. These alpha-beta alloys may be modified further by strengthening the alpha phase with an alpha stabilizing addition at the same time some beta phase is stabilized to room temperature. C-130AM,[4] Ti-4Al-4Mn, is such an alpha-strengthened alpha-beta alloy.

Fig. 2 summarizes these strength-temperature relationships and also emphasizes the significant strength-weight advantage of titanium over other structural metals at various temperatures.

Typical room-temperature mechanical properties of Rem-Cru examples of these titanium grades are given in Table 1.

Fabrication

We already have seen the need for special reduction and melting equipment to protect titanium from other elements because of its high reactivity toward them. This strong bonding power of titanium, which is based on the fact that it is a "transition" metal with many more bonding electrons than other metals, such as magnesium and aluminum, exhibits itself in many other characteristics. Its high melting point is the result of this. So is the difficulty encountered in machining and grinding, where again it holds fast to all cutting and

[4] The names of Rem-Cru alloys designate their crystal structure, their yield strength, and their alloying additions. Thus C-130AM refers to a combined alpha-beta alloy of 130,000 psi minimum yield strength containing aluminum and magnesium. Similarly, A-110AT refers to an alpha alloy of 110,000 psi minimum yield strength containing both aluminum and tin.

grinding tools and so chemically wears them away, and in sliding contact with itself or other materials—even glass—on which it seizes and galls.

Grinding and Machining. Grinding and machining are good illustrations of the practical value and applicability of the foregoing fundamental viewpoint. Stainless steel is more difficult to machine than plain, low-carbon steel and this has been attributed to its high rate of work-hardening and low thermal conductivity. Titanium was found to machine about like stainless and also had low thermal conductivity. It was understandable, therefore, that its relatively difficult machinability should be attributed, in part at least, to a high rate of work-hardening under the cutting tool.

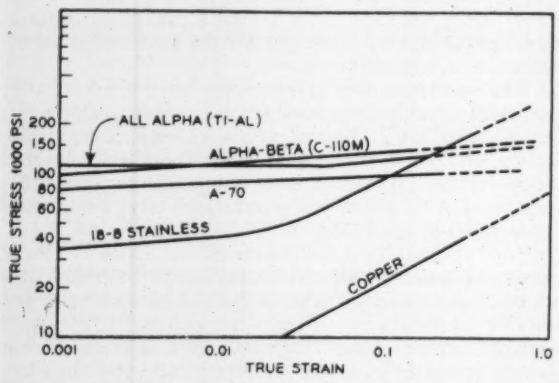

Fig. 3 True-stress true-strain curves for 18-8, Cu, A-70, C-110M, and Ti-7Al titanium and titanium-base alloys

However, Fig. 3 shows that titanium and titanium-base alloys have relatively low rates of work-hardening. The explanation for the machining difficulties of titanium lies in other factors. Once properly understood, appropriate corrective measures can be devised and taken.

In grinding titanium, for example, initially it was found that the wheels wore away as rapidly as the workpiece. It was also noted by Tarasov of the Norton Company that the abrasive grains, many times harder than any titanium metal, were heavily scored rather than broken off as in most metal grinding. Tarasov reasoned that a chemical reaction, similar to that occurring between molten titanium and all known refractories, caused the scoring which added up to phenomenally fast wear.

One solution is to lower the amount of heat put into the metal by lowering the wheel speed from the usual 6000 sfm to 2500 sfm. This reduces the brilliant voluminous spark stream to occasional relatively short sparks and, considerably more to the point, greatly increases the efficiency of grinding.

Another is the use of a grinding fluid which presumably inhibits the hypothesized chemical reaction between the abrasive grains and the titanium. This has been found to increase severalfold the benefit derived from the reduced speed. Water and CO_2 have been found to be worse than dry grinding and, with water-soluble grinding fluids, the grinding efficiency was found to be higher the lower the water content.

Recommendations for Finishing. Tentative recommendations for finish surface-grinding titanium and the current alloys are as follows:

1 Use open-grain aluminum-oxide abrasive wheels.

2 Use low wheel speeds of 2000-3000 sfm. This is the key to the success of precision-grinding titanium parts.

3 Table speeds should be fast—400 to 500 ipm.

4 Down feeds should not exceed 0.001 in. per pass if dimensional accuracy is important.

5 Grinding should be done wet whenever possible to minimize the fire hazard. Avoid fluids which may contribute to the fire hazard. Use fluids such as rust inhibitors which inhibit chemical reaction between the abrasive grains and titanium.

In machining, the abrasive grinding grains are replaced by cutting tools but titanium appears to react chemically with them just as readily. Other factors are of course involved but chemical reactivity is often associated with them. For example, as one result of these other factors, the bearing area of a titanium chip on the cutting tool has been found to be considerably less than is the case with steel. It is believed that this is one reason why excessive tool use is encountered during machining. Also, titanium's relatively low modulus of elasticity and modulus of rigidity coupled with its high yield strength are believed to cause chatter in single-point turning operations.

An associated phenomenon is the poor surface sometimes obtained with interrupted cuts as in a milling machine. When conditions are right—or rather, from the standpoint of the machinist, wrong—chips tend to alloy and weld to the cutter and, at the start of the next cut, to break off.

The corrective measures then are to minimize the chemical reaction between tool and work. One of the most effective ways to accomplish this is to reduce the temperature by the use of CO_2 coolant.

Recommendations for Machining. Other general recommendations for machining titanium consistent with this chemical-reactivity mechanism include the following:

1 Use slow speeds and heavy feeds.

2 Do not allow tool to ride on work; minimum depth of finish cut: 0.003 in. Each tool must cut.

3 Use efficient coolants (liquid CO_2) or effective lubricants (sulphurized oil).

4 Clear chips from work to prevent loading.

5 Keep tool beneath the hard oxidized surface of forgings and bars. Do not allow the tool to emerge from work.

6 Use sturdy equipment to avoid chatter.

It is worth emphasizing that those organizations which have had to face up to and solve the titanium-machining problems if they were to use the metal at all extensively—the jet-engine manufacturers—have been successful to the point where their titanium-machining operations are feasible in production on a relatively large scale.

Sawing. Titanium and its alloys may be cut readily with power hack saws providing the same principles just discussed are employed. These include the use of 3 to 4-pitch saws; maintain positive feeds of about 0.010 to 0.015 in. per stroke; and hold speeds in the range of 25 to 35 fpm. It is also important to flood the work with a coolant so chips are washed away to prevent their being recut. Saw life also will be increased if any oxide scale is removed from the piece being cut by grinding before sawing.

Welding and Brazing. Heating titanium parts together in a vacuum quite effectively joins them—first the oxide

skin is absorbed and then mere contact is sufficient for a strong bond.

If the atmosphere is excluded by one of the noble gases or by other means (for example, vacuum or, as in the case of resistance welding, by the pieces being joined) joining of titanium to itself by fusion and resistance welding is accomplished readily.

C-type alloys, however, are subject both to quench hardenability and to freezing segregation which tend to make their welds brittle. Postwelding heat-treatment may mitigate this embrittlement in some cases and still other expedients may develop or maintain ductility in C-type alloys. At this time, however, it appears that the A-type alloys usually will be employed where ductile welds are required.

With a few notable exceptions, like silver and vanadium, titanium forms brittle intermetallic compounds or phases with all its alloying elements. As a result, although joining to dissimilar metals by welding has been easy, the bonds invariably have been brittle and this has not been susceptible to correction by heat-treatment. Similarly brazed joints have been brittle, although silver has shown some promise in this respect.

Heat-Treatment Response. The A-type materials do not show any heat-treatment response which increases strength. The C-type alloys, on the other hand, are quite quench-hardenable. The basic mechanism is that elevated-temperature heating produces more beta than at room temperature and some of this can be retained by more or less rapid cooling until, either during the quench or on subsequent aging, some of the beta transforms to alpha in such a manner as to strengthen the material. In the case of many common alloying elements, some eutectoid hardening also may be involved.

An example of the enhancement of tensile properties of C-130AM (Ti-4Al-4Mn) which may be obtained by heat-treatment is given in Table 2.

Table 2 Comparison of Ti-4Al-4Mn Production Rod Samples

	Tensile strength, psi	0.2% offset yield str, psi	Elong in 4D, %	Red in area, %
Heat-treated, avg	173000	159000	14.5	28.0
As-received, avg	160000	149700	16.6	36.5

Formability—Both Cold and Hot. At any given strength level, the bend ductilities of alpha alloys are considerably poorer than are those of beta compositions. Heating up to 1000 F will impart to an alpha alloy the superior bending properties of a beta but often hot-forming equipment either is not available or is not feasible. In such cases a beta alloy will have an important advantage over an alpha alloy when it becomes available.

In such cases, also, an alpha-beta alloy has an important advantage over an alpha composition. As mentioned earlier, the bend ductility of an alpha-beta alloy reflects, roughly, the proportions of alpha and beta present—the more beta, the better the bend. In an alpha-strengthened (and correspondingly, therefore, alpha-embrittled) alpha-beta alloy, the presence of some beta cannot make up for the bending deficiencies of the alpha and the bend ductilities are closer to those of an all-alpha. The C-110M is an alpha-beta alloy with unstrengthened alpha and is one whose good bend ductility recommends it for the sheet-forming operations such as are involved in airframes. C-130AM is an alpha-strengthened alpha-beta whose poorer bend ductility excludes it from some sheet applications but whose better hot strength fits it for plate, bar, and forgings where bend is not a predominant factor. Thus it is being used extensively in jet engines.

The two-phase alpha-beta alloys exhibit relatively low strength at temperatures above about 800 F relative to the single-phase all-alpha or all-beta alloys. On the debit side, this means lower yield and creep strengths for the alpha-betas in the important service temperature range of 600–1000 F. On the credit side, it means easier forging and rolling in the important hot-forming range of 1200–1800 F.

The explanation for the lower hot strength of the two-phase alloys lies in the fact that, as the temperature is raised or lowered, the proportions of alpha and of beta change. Transformation of alpha to beta and vice versa is accomplished by shearing movements of atom planes and these are similar to slip movements. During any hot-working operation there are considerable temperature changes which initiate these shearing movements. These co-operate with external stresses tending to cause slip and the net result is lower strength.

These crystal-structure considerations apply also to the temperature ranges employed for forging but other factors must be considered as well. Generally speaking, the forging temperatures of the various alloys are a compromise between the increased plasticity of higher temperatures and the decreased oxidation of lower temperatures. Both these factors are affected importantly by the crystal structure of the alloy—plasticity, as previously indicated, and oxidation by the fact that beta is more vulnerable to oxidation than alpha. The oxidation resistance of a particular crystal structure may vary with its alloy content; for example, the aluminum in C-130AM permits higher forging temperatures than those used for C-110M (Table 3).

Table 3 Forging Temperatures of Titanium Alloys

Alloy type	Forging temperature, deg F
Alpha	1900–2000
Alpha-Beta	
C-110M	1600–1750
C-130AM	1650–1800
Beta	1600–1700

Deep-Drawing and Stretch-Forming. These are other important fabrication operations which depend on a different property, that of uniform elongation. The previously mentioned low work-hardening rate characteristic of titanium is detrimental in this respect. Both deep-drawing and stretch-forming can be accomplished quite successfully in the shop but particular care must be exercised.

An example of the latter is the use of as slow a forming speed as possible. Doubling the bending or stretching time in a particular operation, for example, has been found to reduce cracking rejects from 50 per cent to less than 5 per cent, all other factors remaining equal. With titanium, the slower the speed of deformation the lower the flow stress and the greater the ductility.

Effect of Rate of Working. As indicated in the previous section, titanium is quite sensitive to strain rate. It is in fact more sensitive in this respect than any other structural metal with its strength increasing as the rate of strain is increased. The magnitude of this effect is sufficient that ordinary tensile tests must be run under

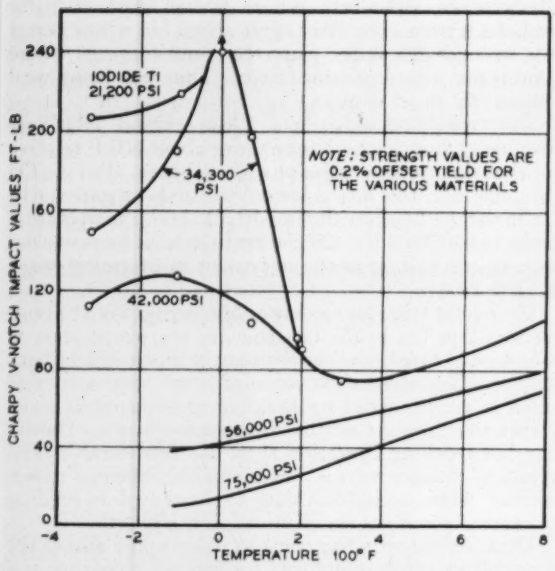

Fig. 4 Charpy-V-notch impact toughness of high and commercial-purity titanium

controlled rates of strain to secure reproducible results.

To form titanium, therefore, work it as slowly as possible. Under rapid loading, however, anticipate surprisingly good performance. This is illustrated in Fig. 4. As this figure also illustrates, titanium can become notch-sensitive at low temperatures and only careful control of chemistry and processing can avoid this.

Creep and Fatigue

Creep. Creep can be considered as a very low strain rate. Consistent with the foregoing section, therefore, it is not surprising to find that the creep strength of unalloyed titanium is appreciably lower than its yield strength. Its creep strength is, in fact, only about three fourths that of the yield at room temperature. Where the crystal structure is strained either by cold-work or by alloying, fortunately it has been found that this percentage is raised up to about 90 per cent.

The foregoing is, however, only the room-temperature behavior. As Fig. 5 shows, the relationship between the creep and yield strengths is temperature-dependent and, at moderately elevated temperatures, the creep strength of unalloyed titanium is actually higher than the yield strength.

To the designer, this simply means that the weaker link in the performance chain may be either creep or yield depending upon the temperature. Hence he must consider both in his calculations.

Fatigue. The accumulation of comprehensive fatigue data is time-consuming and early designs are often necessarily made with substantial safety factors. Now that such detailed data are becoming available for some of the Rem-Cru grades, advantage can be taken of the full value of the properties of the metal. While the many detailed fatigue curves necessary to characterize an alloy will not be presented here, the following paragraphs summarize some recent results:

A-70. Tests conducted in R. R. Moore rotating-beam fatigue machines at 10,000 cycles per min show that material has an endurance limit of 62,000 psi at 10^7 cycles for smooth specimens at room temperature. This is 65 per cent of the room-temperature tensile strength, a value somewhat higher than the values ordinarily observed for steel. Using a 0.010-in-root radius notch, the notched endurance limit is 36,000 psi or 38 per cent of the ultimate tensile strength. This ratio of notched to smooth endurance limits indicates that this material is not unusually notch-sensitive under the test conditions.

C-130AM. Testing under conditions similar to those used for A-70, this material has an endurance limit of 90,000 psi for smooth specimens (59 per cent of the tensile strength), and 45,000 psi (30 per cent of the tensile strength) for the notched ones.

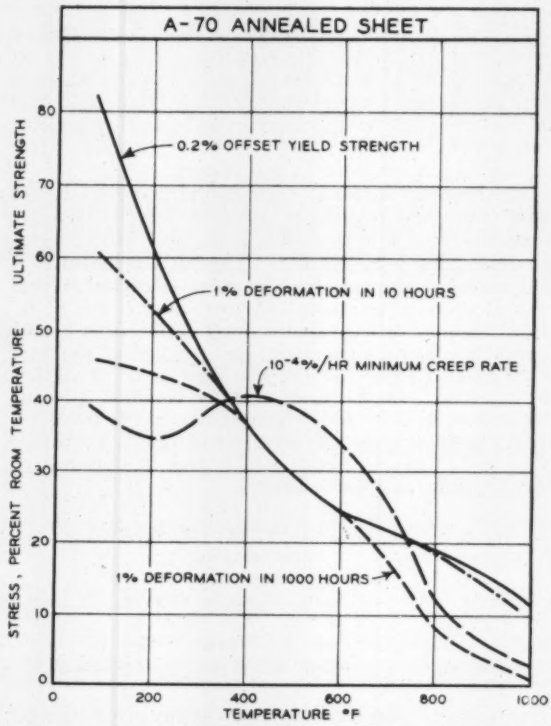
A-70 ANNEALED SHEET
0.2% OFFSET YIELD STRENGTH
1% DEFORMATION IN 10 HOURS
10⁻⁴%/HR MINIMUM CREEP RATE
1% DEFORMATION IN 1000 HOURS
STRESS, PERCENT ROOM TEMPERATURE ULTIMATE STRENGTH
TEMPERATURE °F

Fig. 5 A-70 comparison of yield and creep strengths

C-110M. Only tension-tension fatigue-test data, determined on a Krouse direct-stress machine, are yet available for this material. These data show a scatterband indicating an endurance limit between 66 and 79 per cent of room-temperature tensile strength where S min = 0.25 S max. Additional tests are under way.

Conclusions

In a period of approximately 5 years, titanium has grown from a laboratory curiosity into an industrial material with a production capacity of 5000 to 6000 tons per year. This is the result of the excellent strength-weight ratio of titanium and its alloys coupled with useful properties in the temperature range up to 1000 F. It is the authors' conclusion that the present achievements are outstanding and titanium's future rates a basic confidence in its long-term success in contributing substantially to our society in both war and peace.

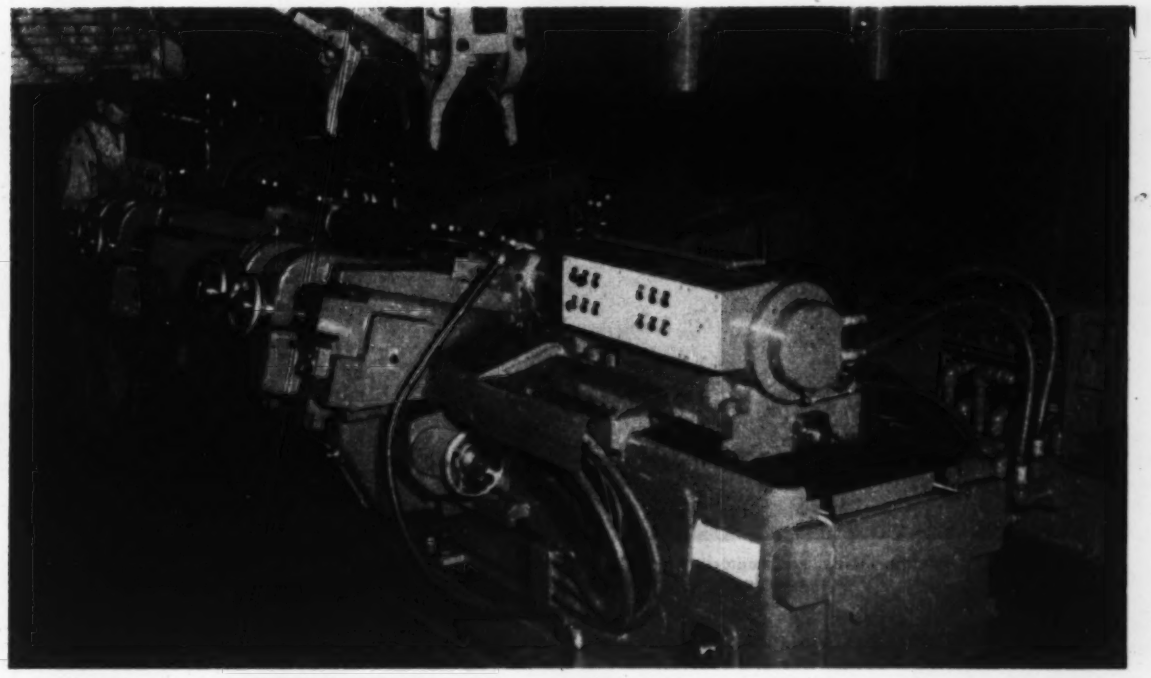

Fig. 1 Multiple-tool axle-roughing lathe designed to operate with six tools on operator's side and four tools on back side

Production Tooling in a Steel Plant

How improved production has resulted from better methods and modern tools. Carbide-tool applications including specific machining data are reviewed. Maintenance-tooling developments illustrate what planning and ingenuity in machine-tool applications can do to reduce costs.

By C. E. Youngblood

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When the production frenzy brought on by World War II subsided in the mid-1940's and new machine tools began to become generally available for peacetime production, a program was instigated to replace some of the slow or worn-out equipment with new high-speed machines. Improvements in carbide tools and their increasing availability gave rise to the consideration of replacing as many of the slower machines as practical with new ones capable of speeds sufficient for proper utilization of carbides.

Contributed by the Research Committee on Metal Processing and presented at a joint session of the Research Committee on Metal Processing and Production Engineering Division at the Semi-Annual Meeting, Pittsburgh, Pa., June 20–24, 1954, of The American Society of Mechanical Engineers. (Condensed from ASME Paper No. 54—SA-38.)

Multiple-Tool Axle-Roughing Lathe

Among the first new machine tools installed after the war, in the production line, was a multiple-tool axle-roughing lathe, Fig. 1. This lathe was designed to operate with six tools on the operator's side and an additional eight tools on the back side. An automatic air and electric-controlled loading and unloading arrangement was installed with the lathe. All tool positioning, feeding, and withdrawing is hydraulically operated and automatically controlled. Chip removal is accomplished by a shaker conveyer which delivers the chips to a pit, from which they are removed by a bucket elevator to a fork-lift truck which in turn delivers them to a scrap bin.

Fig. 2 Automatic sawing, facing, and centering machine in combination with the axle lathe makes it possible to take the forged axle stock and produce a rough-turned axle complete

The automatic lathe was designed for high-speed operation and carbide tooling, but a great deal of experimentation was necessary before an even satisfactory performance was achieved. It was necessary to vary both the feed and speed of the lathe and the grade of carbide used. It was soon found that minor variations in either feed or speed would set up vibrations which resulted in shattered tools.

After numerous attempts, it was concluded from the test results to do all turning at a speed of 320 sfm and a feed of 0.024 in. per revolution (ipr), using carbide tools made of Grade KM or its equivalent. The type of tool used has a steel shank measuring $1^1/_4$ in. $\times$ $^3/_4$ in. in cross section with an induction-brazed carbide tip. After much experimentation, it was decided that six tools on the operator's side and four tools on the back side would give the best results. The grade of steel ordinarily handled on this machine is SAE 1045 (untreated as forged), having a hardness range of Brinell 215 to 235.

Under the conditions just described, the complete cycle for one axle is $3^1/_2$ min, and a production of 80 axles in an 8-hr turn is considered average. This, of course, includes loss of time for various operating delays. The figures here presented, for feeds and speeds for rough-turning, may not agree with published figures which are supposed to represent optimum conditions. However, they produced the best results in surface finish, tool life, and the general maintaining of production level for this machine.

It should be stated further that a constant search is being made for better tools and better feed-speed combinations.

Automatic Sawing, Facing, and Centering Machine

Several years after the axle-roughing lathe was placed in operation an automatic sawing, facing, and centering machine was installed just ahead of and in line with the roughing lathe, Fig. 2. The operations on the new machine in combination with the axle lathe made it possible to take the forged axle stock and produce a rough-turned axle complete. Prior to this time, the operations of cutting the stock to length, and centering the axle on both ends, had been done on a slower machine with nonautomatic loading and unloading. The finish-milling operation on the new machine was not done previously. To attain the proper tooling, the automatic machine was subjected to a process of evolution similar to the one just described for the lathe. The saw and center drill are high-speed steel, while the face mill uses K2S carbide inserts.

High-Speed Tools for Wheel and Axle Production

In a department devoted to wheel and axle finishing and assembly, two automatic high-speed machine tools were installed. The first is a finishing lathe similar to the roughing lathe, described previously, operating at 320 sfm with a feed of 0.046 ipr, cycle time of 2.80 min per axle, and using carbide Grade K6. The second is a vertical boring machine with a rotating spindle having a two-speed cycle, Fig. 3.

The latter machine in one operation roughs and finishes the bore of a wheel. The spindle is equipped with four carbide tools (Grade K4H) of the clamp-on button type. As soon as the first four tools complete the roughing cut at 160 rpm, the spindle automatically decreases to the finished speed of 83 rpm and the second tools (2-cobalt-based) begin the finish cut. This machine is equipped with air-controlled automatic loading and unloading devices. Total cycle time to rough and finish a wheel bore on this machine is 2.1 min, including loading and unloading.

New Machines for Wheel Roughing

The unit of the plant which produces wheel forgings has a machine-tool section in which wheels are roughed to within $^1/_8$ in. of finish dimensions in the bore. Four new machines have been installed in this location within the past 4 years. Two of these are vertical boring ma-

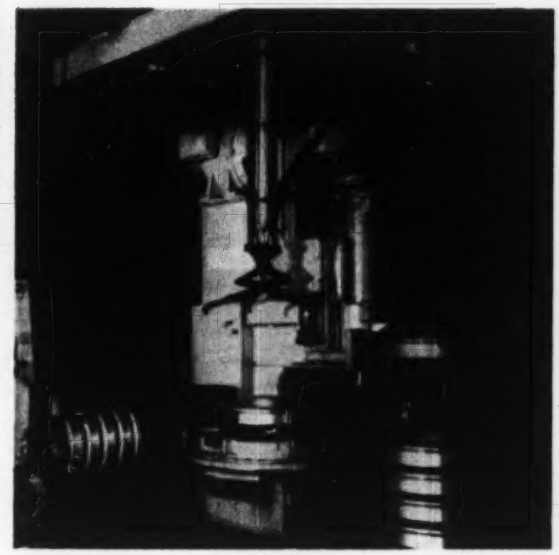

Fig. 3 Vertical boring machine with a rotating spindle having a two-speed cycle

chines similar to the one just described. They both use the carbide button cutters although, for bores of less than 5 in. diam, carbide-tipped fly-cutters are used on one of the machines. These two boring mills also are equipped with automatic air-activated loading and unloading devices.

Production experience has indicated from 100 to 200 per cent increase over the old-style machines which utilized high-speed-steel tools. Cutting data on the roughing of wheel bores are as follows: $^1/_2$ in. depth of cut, feed of 0.031 to 0.041 ipr, depending on material, at 150 rpm spindle speed. This cutting performance is achieved with 1-in-diam carbide buttons, Grade K4H, at a rate of 25 wheels per button position and from 6 to 8 indexes per button. When a fly cutter is used, from 50 to 70 wheels per tool are bored, cutting to depth of about $^3/_8$ in.

The other two machines recently installed in this section are conventional-type boring machines with rotating tables, which use straight-shank tools tipped with carbide grade KM or K2S—and also the K4H 1-in-diam buttons. These machines are used for special work and are not on continuous-type production items, but general comparisons indicate at least a 100 per cent increased output over older machines.

The grade of material cut by the new machines in the wheel division is, for the most part, in carbon range of 0.60 to 0.80, both as-forged and heat-treated.

Machining Mill Rolls

In 1948 an engine lathe having a swing of 32 in. and a bed length between centers of 84 in. was installed to machine mill rolls for various bar and billet mills, Fig. 4. This lathe was equipped with an electrical contour control, and the automatic tracer finger, with which this device was equipped followed a metal template. This lathe proved so successful that another 32-in. lathe with 108 in. between centers was added about a year later, and a third lathe with 34-in. swing and center distance of 126 in. was installed in 1952. The two latter lathes were also equipped with the electrical tracer attachment.

The rough and finish-turning done on these lathes is accomplished with carbide-insert-type tools, Grade K6, or their equivalent. Experience has indicated that from two to three times as much work has been done by these lathes as was accomplished previously in the same time interval on slower, conventional, roll-turning lathes.

Tool-Preparation System

Most of the machine tools discussed in this paper utilize carbide cutting tools. As these machines were added to the plant, a constant increase in demand for new and reground tools made it necessary to expand the tool-grinding facilities. It soon became apparent that a separate tool-preparation section would be required. Lack of co-ordination in operation, duplicate handling, poor storage facilities, and crowded conditions were inflating the tool-preparation cost.

An available floor area was located and a careful layout of machines on hand was made, leaving sufficient room for new equipment. In order to integrate the tool production properly in the new grinding room, some small vertical and horizontal milling machines were purchased for the purpose of preparing the steel shanks

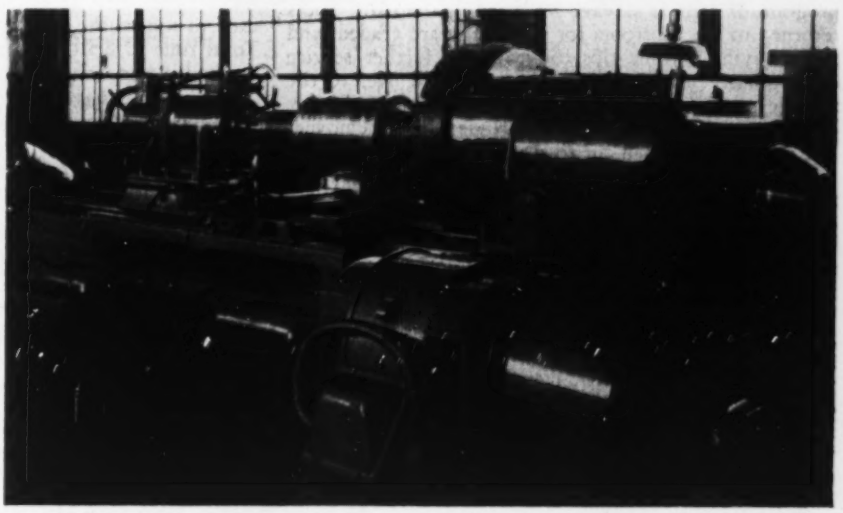

Fig. 4 Engine lathe with swing of 32 in. and a bed length between centers of 84 in., for machining mill rolls

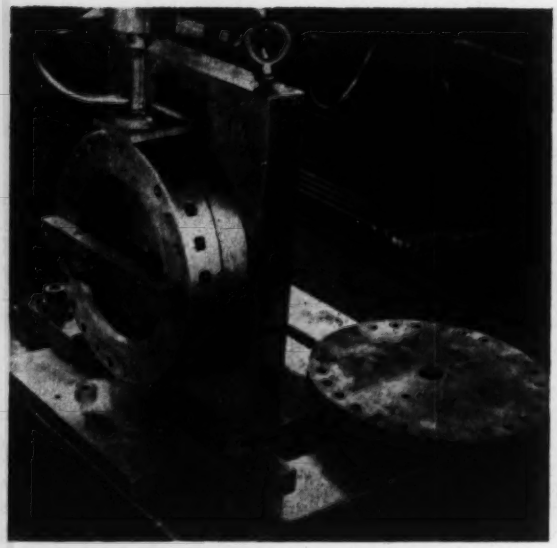

Fig. 5 Stamping wheel for a billet mill reduces repair costs

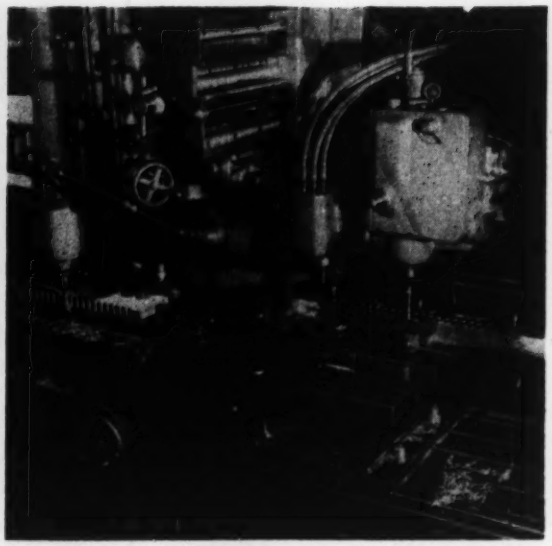

Fig. 6 28-in. vertical milling machine with hydraulic tracer

on which the carbide tips are induction-brazed. When the machine tools were installed in the new grinding room they were so arranged that the flow of materials would be progressive with the proper succession of operations, eliminating most, if not all, of the duplicate handling.

The success of this integrated grinding and tool-preparation program has been reflected in lower tool cost and capacity to meet the plant's tool requirements, with reserve capacity to take care of additional future requirements. As the grinding room is presently equipped it is producing daily about 450 tools of various sizes and descriptions, with a force of 15 machine operators and one foreman.

Carbide Salvage

In an effort to keep new tool cost to a minimum, a program of carbide salvage has been instigated. Tools returned to the toolroom for regrinding are graded, and those having carbide tips too thin for further service as originally used, or broken, are turned over to the salvage group. These tools are then taken to the frequency generator, where the carbide tip is removed. The used tips are then cut to size for milling cutters and various small-tool applications on a carbide cutoff machine.

The machines described thus far have been production tools. The machine shop, in which the tool-grinding room is located, is equipped with machine tools of many types and is capable of producing repair parts for most breakdown items which occur in the plant and the manufacture of new equipment. As is the case in many similar steel-plant shops, most of the machine tools were not designed for carbide cutting tools, and the use of such carbide tools is therefore restricted to the newer machines. There would be little gained to describe the variety of jobs handled or the machining data relating to them. It should be pointed out that all work is performed, wherever machine-tool limitations do not prevent it, in accordance with standards established in the ASME "Manual on the Cutting of Metals."

Repairing Mill Parts

Over a period of years many improved methods have been devised which have reduced the repair cost of specific mill parts. One such item is a stamping wheel for a billet mill, Fig. 5. This wheel has square holes on the circumference which hold the letter and number stamps. As the hot billet is passed through the finish pass of the billet mill it is forced against the stamping wheel, and identification codes are impressed along the length of the hot billet.

The square holes in the stamping wheel always have presented a problem to the machine shop. With the method followed for many years, it took about 24 hr to lay out, drill, slot, and file 24 square holes on one such wheel. Recently an indexing jig was designed, and the 24 holes were drilled with a square-hole drill on a small radial drill press. After the drilling, a drift was used to square the hole and true it to final dimensions. Total time to drill and true all 24 holes using the new method is 4 hr, or a saving of 20 hr on the job.

Several jobs have been completed in greatly reduced time on a 28-in. hydrotel vertical milling machine equipped with a hydraulic tracer, Fig. 6. Since the plant has several bar mills there always has been a major problem in machining shear blades to accomodate a wide range of bar sizes. Several different procedures have been tried over the years and, until recently, the best time for a shear blade for $2^1/_8$-in. rounds was 5 hr and required setups on three different machines—planer, drill press, and shaper.

Using the 28-in. hydrotel with a template cut to match the finished blade, the entire job was done on one machine with one setup in 1.6 hr, or a saving of 3.4 hr.

Such improved machining methods effect savings in many ways in a maintenance shop. By reducing machining time quicker deliveries can be made, and less mill delay time is experienced in emergency breakdowns. Cost reductions result in several ways; less shop time and less overhead per piece machined, reduced tool cost, and in many cases less handling and material movement.

How to Manage Engineering Personnel

By Samuel Storchheim

It is a simple matter to master the art of handling people to procure their best efforts. Sincerity, loyalty, understanding toward associates are the basic principles upon which the success of a supervisor depends. A practical guide toward accomplishing this result is outlined.

Success in management depends upon our ability to get the people being supervised to work efficiently and to produce good results.

By far the most important men with whom a supervisor deals are those who take orders from him—senior and junior engineers and their technicians in the case of an engineering department. It is their morale and the results they produce which ultimately decide whether the supervisor is successful. It is basic that the supervisor assume an attitude of respect and friendliness toward his men. They will return this respect and lend support to his efforts upon which his success as well as their own depends.

From the start it is vital that a mutual understanding be reached. The criterion is the supervisor's sincerity. False flattery and false pretenses will become unmasked and he will become known as insincere—one who cannot be trusted; the result—loss of respect and support of his men. Hence it should be emphasized that if it is not part of a supervisor's basic nature to be sincere then he must try to make it so. His men come first—this is a fundamental law for the successful management of people.

Perhaps the initial clue in handling the men under him is as follows: When in doubt as to how an average person will react to some particular instruction or situation, the supervisor should project himself into that man's position. Just how would he feel under the same circumstances. This technique is excellent, provided the supervisor is honest with himself—"to thine own self be true." He should not force his reactions in the direction of his own desires.

● Direct Attitude of Supervisor Toward His Men

An itemized list of a number of the "attitudes" a supervisor should have toward his men follows:

1 It is vital that you, the supervisor, always should try to stand up for your men and that they know it. Protect them—make every effort to gain recognition for them orally and in writing. Above all, make sure they are compensated in their pay checks. Let them know how you feel about their work. It gives your men a sense of balance so they can anticipate the future.

2 Avoid destructive criticism at all costs. Let reprimands assume the nature of advice from a friend. Don't gloat over mistakes. Discuss the basic facts to avoid recurrences. Remember, no man likes to be criticized, and that includes everyone, even if the criticism is justified. Every man feels he is incapable of being or doing wrong. Don't "knock the skids" out from under suggestions made by your men. Try some—many of them may work and solve difficult problems. As the supervisor you should give freely of your knowledge; that is, don't keep secrets. Encourage your men to be the same way. If you know of short cuts and have ideas that work and are not generally known, give them out, let the men learn. Let them help you. If you have good ideas, don't be afraid they'll be stolen, because there always will be other ideas coming along. This also applies to others. If one of your men has a good idea, tell him it's good. Don't criticize it and attempt to destroy his initiative. That is stupid. Every man likes a pat on the back—be he a little guy or a big guy. So go out of your way to give credit where credit is due. Do not argue or attempt to impress an expert in a field you are only vaguely familiar with. If such a man works for you, let him teach you.

You are a leader but no one expects you to be an expert in all technical fields. It is important for you, though, to have a good general technical background in order to understand and accept the data, the trends, the new ideas and concepts that this particular man or any other man gives you.

3 Occasionally the author has observed a serious error practiced by some supervisors. The error is that they stand over their men and watch them. No one likes this treatment. Most people become nervous—in effect, seized by stage fright. A supervisor must remember that a little "goofing-off" on the part of the men under him is normal and good for them. It breaks the "grind" of work and allows for relaxation. As long as you feel your men are producing an honest day's work, don't be upset by their "rest periods." Of course, where necessary, unduly long periods have to be cut down. In doing this, be diplomatic.

On the other hand, don't let your men "bulldoze" you, if a man is not producing and has all sorts of excuses for delinquency, try him at other jobs in your group. Normally, he will find his niche. If he still fails to produce satisfactorily, transfer him to another group. There is a place for every man, and if the men under you realize that you recognize this fact, they will feel relaxed and relieved. They will be able to work without the sort of mental disturbance caused by the lack of job technique on their part. Many instances may be mentioned where a misfit in one area has done

commendable work somewhere else. It is important to recognize the fact that keeping a man who is unhappy at his job or who feels that you are dissatisfied with his work will cause discontent and poor morale not only to himself but to the whole group with which he works.

4 If you notice a man's output is dropping off and his work is falling below his standards of quantity and quality, have a talk with him.

Use only constructive criticism. Keep posted on his production and very soon after the talk try to find something to commend him for. This encourages him and gives him self-assurance. He realizes you are his friend trying to help him and not attempting to hinder or hurt him.

Don't pamper your men or compromise yourself. Treat your men with respect but always on a high plane. If they try to take advantage of you over a period of time (it is wise not to "blow up" over several isolated instances) then meet with them in private and "give it to them straight." Be honest and factual. Tell them what you think of them and why you don't like what they're doing.

Don't be coerced. If a man says he'll leave, then wish him luck and say goodby; this usually works wonders; the men suddenly realize that no matter how good they are, they are not indispensable. If they are paid a decent salary and treated fairly, they probably will not leave the company. They also will have a great deal more respect for you. They will realize that although you are a considerate pleasant person you still cannot be pushed around and you still expect good work.

5 It is wise always to attempt to teach your men. This pays off in the long run because eventually they will start solving problems by themselves without having to come to you for aid. Further, it has been found worth while to sit down with the men and encourage them to improve themselves by any of the following methods: (*a*) Local schooling; (*b*) correspondence schooling; and (*c*) company lectures. If you show them that you are interested in furthering their careers they certainly will respond. Advise them on how their additional effort will push them forward and how the company will profit. Advise them how their extra efforts will pay off in advancing their careers, in compensation by way of their pay checks, and above all, the stimulus to be gained by getting new ideas and broadening their acquaintance with ambitious interested people.

Try to vary the work of your engineers—in fact, all your people.

Many young engineers quit their jobs because their work becomes stultified, with no challenge. Give your men something they can "get their teeth into"—something new, something different. This does not mean every day, every week, or every month; but at least, say, every year. Try to turn over new problems to them.

Take your men into your confidence; give them an idea of the group's plans for the future. "Breathe the life of belonging into them." When they are depressed or elated over results obtained, this is your clue as to the fact that they now "belong." Wherever possible let them know how company or department finances are so they can appreciate the need for saving money. This can produce startling results. Actually, it can mean the difference between success and failure of a department and even of a business.

6 The foregoing are the basic techniques for handling men. However, you may have trouble with a new man until he realizes that what you are trying to do is honest, sincere, and for his own good. On occasion it has happened that application of these principles of supervising management has aroused the suspicions of a newcomer. When such an individual realizes that what is being done is a sincere effort to accomplish good not only for him but for the general welfare of the company as well, he becomes a staunch ally and friend of the supervisor.

The author presents a number of techniques regarding the handling of people, particularly those directly under a supervisor. The suggestions may be criticized by saying that this one works, while another fails to do so, or that some other method may work to better advantage. However, the author states categorically that when applied, the techniques outlined have proved to be successful. After all—what more is required?

● Indirect Attitude of Supervisor

The several items now to be mentioned concern the conduct of the supervisor principally toward himself rather than directly toward his men.

1 One of the first and most important things for a supervisor to know is that he always should be available to his men. He should let them see him regardless of the matter to be discussed. If he is busy he should excuse himself and make an appointment for some later time, but he always should make it an important point to write down what he has to do.

2 Remember this, don't put yourself on a pedestal; remain modest regardless of your accomplishments. Never, under any circumstances—with emphasis on "never"—willingly create an enemy no matter how apparently insignificant his position. By being modest always, in time this characteristic will become a natural part of your behavior pattern. People dislike braggarts and "bullthrowers." Of course excessive modesty is not good either. The results you achieve can become known and recognized by internal company reports, papers presented before technical societies, activities in such societies, and in everyday association and activity with the people of your community.

3 It is advisable occasionally to discuss your problems with others not directly concerned with your immediate work. This helps develop new approaches, stimulates thought and the desire to succeed.

4 Do your best so that at no time do you have to justify your results. Avoid rash decisions. At all times try to keep friendly relationships; if someone is antagonistic toward you avoid contact with him as much as possible.

These are the broad rules for success as a supervisor—follow them.

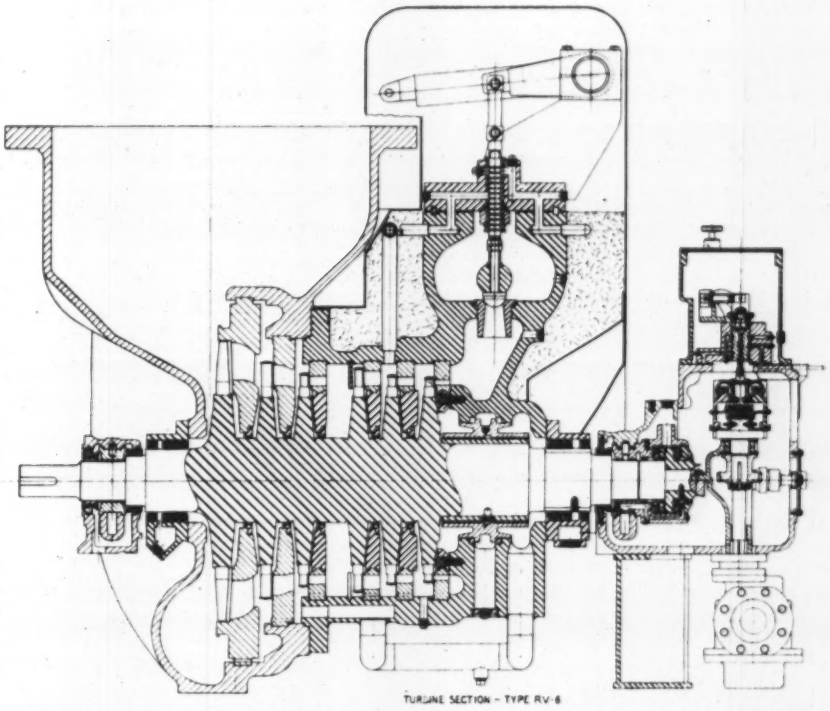

Fig. 1 High-speed multistage turbine for direct drive operates at speeds from 7000 to 12,000 rpm

Future Industrial Turbine and Its Application

Higher pressure and temperature developments in utility turbines point way for industry to increase economy of mechanical-drive turbines and turbogenerators in process and manufacturing uses

By H. Steen-Johnsen

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THE industrial-turbine field may be considered as including 10,000-kw units and smaller, and the field div des into two types of drives. One type is direct mechanical drive of the driven machine such as pumps, compressors, paper mills, and so on, and the other is the turbogenerator for generating electric energy. More than 1,000,000 kw a year of these two types of drives is now purchased by industry. This volume is increasing yearly with the expanding industrial economy. It is expected that the capacity will have doubled in the next 10 to 15 years.

Based on a paper presented at a meeting of the Trenton Sub-Section of the Philadelphia Section, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, Trenton, N. J., April 20, 1954.

Of the two types the turbogenerator is most frequently considered and is particularly desirable when operating noncondensing on process steam. By this means electric energy is obtained as a by-product at low cost.

Economy of Mechanical Drive

The full importance of the mechanical-drive turbine is frequently overlooked by thinking of it as a small single-stage machine only, while closer examination will show that it covers a horsepower range from single-stage 5-hp to 16,000-hp multistage blast-furnace drives and higher for special machines. It accounts for 45 per cent of the dollar volume in the industrial field. For the

future, we know that particularly in the range 3000 to 5000 hp there is a growing demand for multistage high-speed turbines. Furthermore, in the low-horsepower range of the mechanical-drive turbines, where the single-stage machine has been standard, there is currently a trend toward the more expensive multistage machines. These machines with their higher efficiency show up to economic advantage with rising fuel costs and increased value of a pound of steam.

A large proportion of the mechanical-drive turbines are applied to compressors both reciprocating and centrifugal which are installed in refineries and other process industries such as steel-mill coke ovens, gasworks, refrigeration plants, and the like. These applications hold promise of an expanding market. For example, a modern refinery addition may require six or eight compressors of the 5000-hp size. Also, with the advent of the gas turbine, compressor design has received considerable attention; rpm as well as tip speeds are being increased, 900 fps now being common practice. Indications point to even higher speeds than are now available.

In the horsepower range of 3000 to 8000, the driving turbines, Fig. 1, for these compressors operate at speeds from 7000 to 12,000 rpm. Turbines designed for such horsepower and speeds have high tip velocity in spite of reduced wheel diameter. The high disk stresses are handled by solid rotor construction, the shaft and disks being machined from a single forging. At these high speeds, blading and blade shanks receive special treatment.

The last-stage blade for these turbines is tapered and twisted with a high area ratio from the base out to the tip to hold down the stress. At a maximum speed of 12,000 rpm such blades will have a tip speed of 1520 fps, which is about the same as a 25-in. blade on a 50-in. drum used in central-station turbines.

At this speed blading requires careful consideration of resonance and vibration. Because of the variable-speed requirement the fundamental blade frequency must be a higher multiple than is used at 3600 rpm to avoid dangerous excitation at any specified running speed.

The calculated blade frequency is checked by tests consisting of exciting the blades over a wide range of frequencies. Strain gages at the base of the blade connected to an oscillograph will show the resonance points.

For maximum horsepower of around 10,000 in these high-speed frames the last blade row can be doubled; that is, a double-flow exhaust end is utilized.

Trend to Higher Temperatures and Pressures

Following the advances in pressure and temperature of the utility field which have resulted in great reductions in heat rate and fuel consumption, larger industrial turbines such as the blast-furnace turboblower are now being designed for 900 F. For many years these 10,000 to 15,000-hp machines were designed for 250 psig so the change to 800 psig 900 F involves modifications which add to the cost. The compensation from this high pressure comes from steam economy.

If a comparison is made between the 800-psig 900 F machine and the 250-psig 700 F, the former requires 71,000 lb per hr instead of 90,000 lb per hr, a saving of 20 per cent in steam consumption. The inlet steam contains 1457 instead of 1370 Btu per lb, Fig. 2. Actually, the working level and cycle output are increased on the order of 25 per cent.

By-Product Electric Generation

When it comes to generating electric energy as a by-product of process steam by the use of extraction and noncondensing turbines, where a turbogenerator acts as a reducing valve between the boiler and the process-steam header, industry has a combination that is hard to beat.

The advantages of this arrangement increase as the pressure and temperature are raised and 900 F machines already are being accepted widely. While 950 F is still unusual, it appears that 1450-psig 950 F conditions are

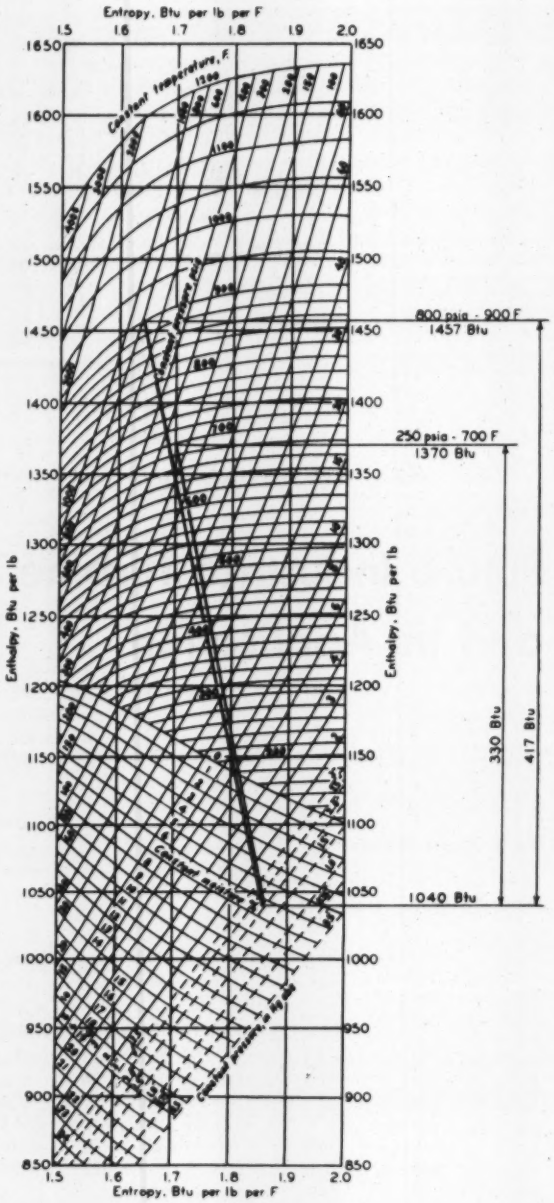

Fig. 2 Comparison of state lines for 800-psig 900 F versus 250-psig 700 F shows 20 per cent saving in steam consumption

reasonable for a 10,000-kw unit with extraction at 400 psig. Such a turbine would have a steam flow of approximately 320,000 lb per hr with steam admission in both upper and lower halves.

The step to 1450 psig requires further modifications of the design to insure reliability. For example, account must be taken of possible temperature distortion and high first-stage pressure and means provided for diaphragm support, special bolting, and shaft seals, Fig. 3.

The rotor construction must be heavy with high-pressure wheels forged integrally with the shaft, pine-tree fastenings on the buckets, and the first-stage bucket equipped with a double shroud, the inner shroud being integral with the bucket.

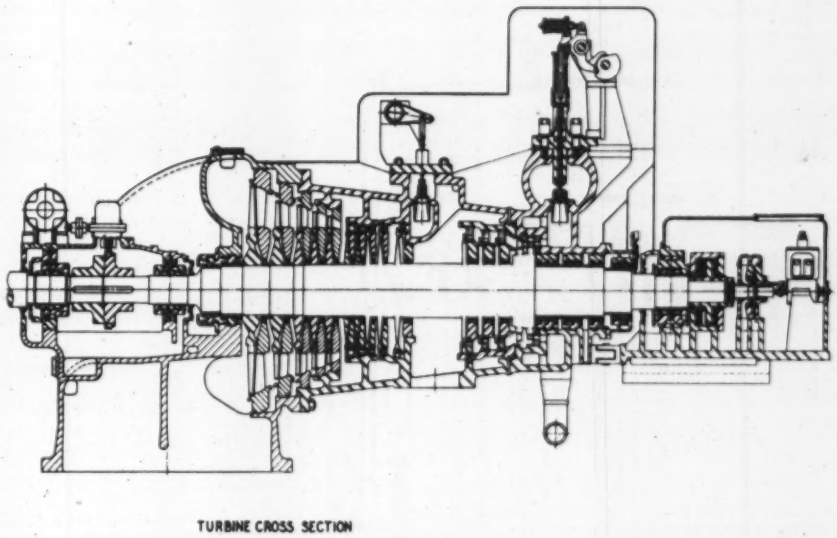

Fig. 3 10-Mw extraction turbine for 1450-psig 950 F modified to insure reliability

Materials used for rotor and casing must be suitable for the high temperatures involved and made of suitable alloys such as Ni-Mo for rotor forgings and casings. Special bolting materials are required.

More Rigid Standards Needed

Industrial requirements involve a great number of turbine sizes and pressures, for which the standards are not well established. In NEMA publication TU-4, standard pressures of 250, 400, 600, 850, and 1450, with temperatures of 750, 825, 900, and 950, respectively, are listed. In general, the various machines required by industry are classified within these brackets. However, below 10,000 kw capacity, there are 8 ratings and 9 inlet conditions so the field covers 72 variations of condensing machines only. This also must be factored by the variations of single and double extraction as well as noncondensing types.

The situation thus becomes extremely involved. To all this must be added off-standard steam conditions which frequently are requested for a noncondensing turbine because the customer requires both dry and saturated steam in the exhaust to be used in the process. This is accomplished by using a fairly high pressure, but a lower temperature. This particular requirement of industry, of having steam conditions at the extraction opening or at the exhaust determine the throttle pressure, is a major difficulty in establishing an acceptable standard for industrial turbines.

Outdoor-Turbine Installations

A discussion of industrial turbines would not be complete without mentioning the possibilities of outdoor-turbine installations. Some parts of a standard turbine must be protected from the weather such as the valve gear on top of the inlet steam chest and the turning-gear motor. Also, there are some openings around the foundation which must be sealed to prevent water from entering the space under the machine. Covering these various parts is facilitated by the addition of ledges to the turbine casing so that a weatherproof jacket can be fastened and extended down to the floor line. Also, around the edge of the foundation where the weatherproof jacket joins the base, a 2-in. curb is built on which the lagging rests.

However, an outdoor installation offers an operating disadvantage which partially offsets the savings in initial building cost. The outdoor installation is particularly undesirable from a service standpoint and erection of an outdoor machine always takes considerably more time than erection of an indoor unit. Also, inclement weather conditions cause construction interruptions and delays.

These handicaps of outdoor installation of course are service and operating problems with which industry must contend. In an industry where continuous service is important, the outdoor machine should be viewed with considerable skepticism, because weather conditions could prolong seriously an emergency shutdown where adequate reserve capacity is not available. An alternative scheme is to erect the machine on a platform with a simple shelter over the turbine to give weather protection for the unit and all operating functions as well as minor service functions.

Wide Variation in Governing Methods

Where a frequency change affects the speed of the production machinery as in a paper mill or rayon plant, close frequency control must be provided for the turbogenerator.

Direct-drive machines in the process industries frequently required that speed and power input be tied into the over-all process control. In a refinery or a coke-oven installation a tie-in with the production cycle is required.

For these various applications it should be kept in mind that on machines larger than the small single-stage, considerable power is required to move the governing valves. On 2000 to 3000 hp and up, particularly multi-

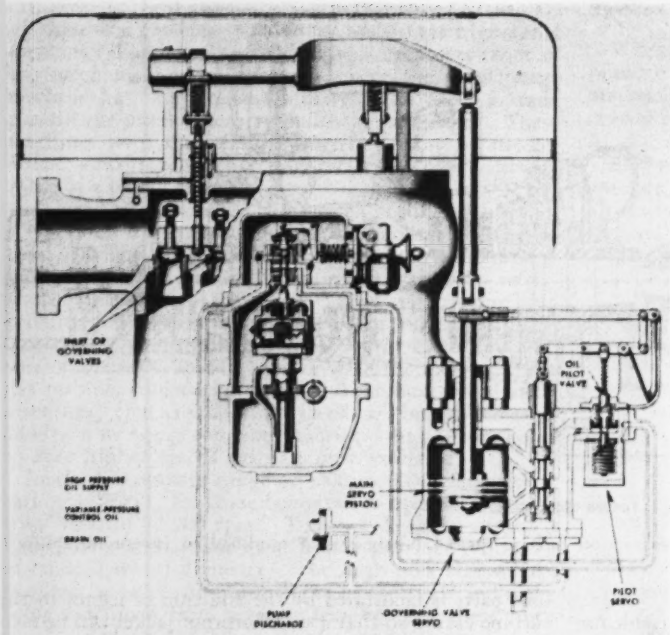

Fig. 4 Speed-governing system with mechanical speed governor and hydraulic control mechanism for multivalve turbine

valve machines, a good-sized and fast-acting oil servo with several thousand pounds push is needed to move the valves. A good speed governor can be completely useless if the rest of the speed-control system is not adequate. The speed governor together with the relays, amplifying devices, servos, and the governing valves, have to be designed and sized to work as a unit, Fig. 4.

In this instance the valves are moved by a double-acting oil servo powered from the main oil supply. This servo is positioned by the control pressure which is the amplified signal from the speed-sensitive element to correct for a speed change.

The speed-sensitive element is a governor in which the motion of the governor weights is entirely by elastic deformation. The pins are supported in rubber bushings that deflect in torsion and the weight connections are flat springs so there is no relative sliding or rolling with static friction to be overcome.

This speed-control system with minor adaptations is also suitable for external control from a process-air-control system. This external control can be either direct-acting on the servomotor and control the energy input to the turbine; or it can be tied into the speed governor so that the process-air control acts on the governor speed changer.

Future Trends

Looking to the future industrial turbine, the thought is frequently advanced that a high-speed turbine and gear might be an advantageous drive for generators, rather than direct drive. A 7500-kw generator could be driven through a gear by a 10,000-rpm turbine and this condensing turbine of small physical size readily could use 1450 psig or higher pressure and 1000 F. Such a turbine conceivably could be fabricated as a unit with the condenser, Fig. 5.

The suggested arrangement in Fig. 5 shows in dot-and-dash outline the standard 7500-kw 3600-rpm turbine; the reduction in size is considerable.

Further study might suggest that the generator be located on a pad at ground level with the driving pinion and turbine shaft vertically above the driven gear.

The turbine center line might be some 6 or 8 ft above ground level and the condenser could be a flat box arrangement.

This unit fabrication would be facilitated further if present experimental work on water-lubricated bearings develops satisfactorily. In such an event the steam seals could be eliminated because the water-lubricated bearings acting also as seals could use condensate for lubrication.

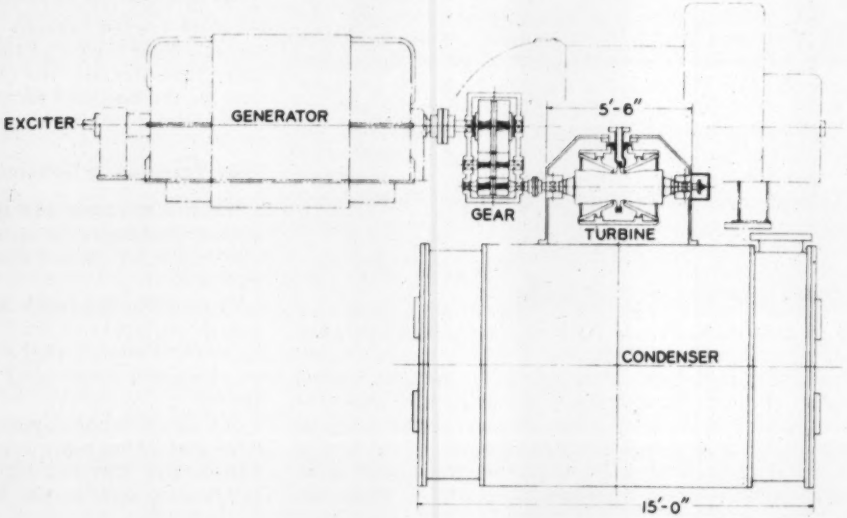

Fig. 5 High-speed turbine and gear for 3600-rpm generator drive—comparative size and suggested arrangement for 7500 kw

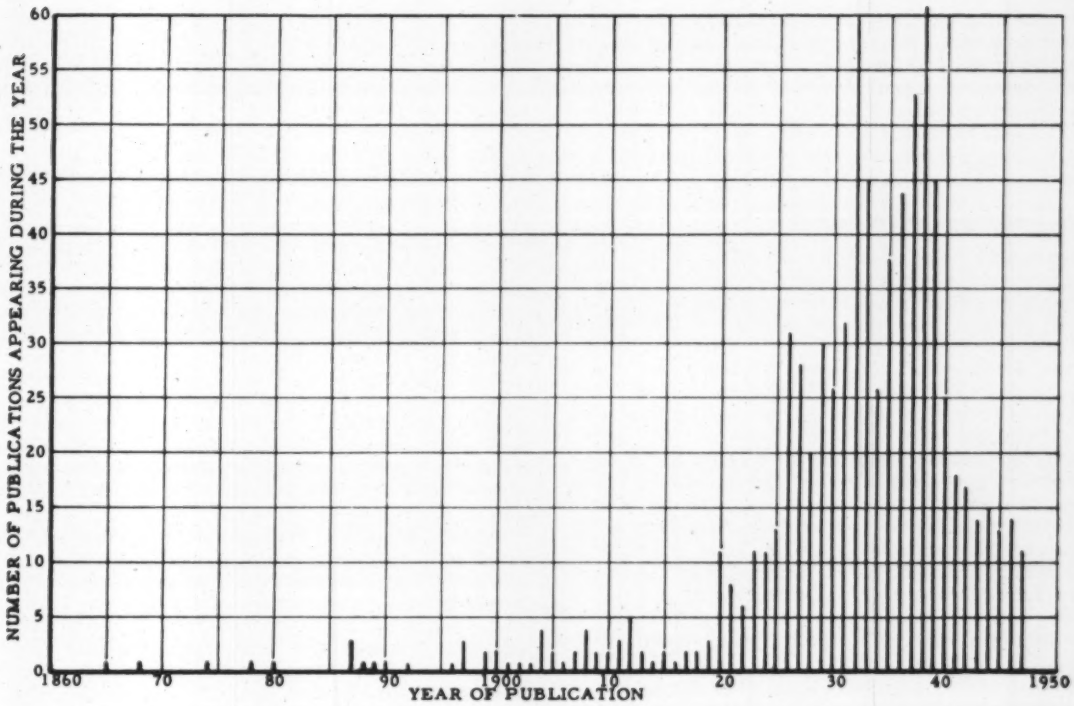

Fig. 1 Growth of cavitation literature—total number of publications on all aspects of cavitation appearing yearly

Present Status of Cavitation Research

By Robert T. Knapp

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The effect of cavitation on performance of hydraulic devices, and losses from mechanical and corrosion damage, have been subject to intensive study for many years. This paper reviews the scope and findings of such studies and suggests the course of future investigations.

In 1947 the David Taylor Model Basin published an annotated bibliography of cavitation (1).[1] The individual annotations make it possible to construct a general development outline of the cavitation field. A few of the interesting high lights are discussed in this paper.

The total number of publications on all aspects of cavitation appearing yearly are shown in Fig. 1. It is a common impression that the hydrodynamic disease of cavitation has been recognized only quite recently. Hence it is a shock to observe that in 1754, in discussing hydraulic turbines, Euler recognized the possibility of cavitation, although he did not call it by that name. However, the nineteenth century was not very productive of articles, since the first one appeared in 1865, and only 18 are found in the 35 remaining years in that century.

The next 20 years showed a definite increase in cavitation interest, since 42 articles appeared, about four times the rate of the previous period. However, during these 20 years the average annual production did not vary appreciably. The big change in interest came about 1920, since the following 5-year period averaged nine articles per year, and the next three 5-year periods averaged 24, 36, and 48, respectively. The latter period, ending with

[1] Numbers in parentheses refer to the Bibliography at the end of the paper.

Presented under the auspices of the Heat Transfer and Fluid Mechanics Institute at the Semi-Annual Meeting, Los Angeles, Calif., June 28–July 2, 1953, of The American Society of Mechanical Engineers. Condensed.

1939, is an all-time high. From 1940 to 1944 the yearly average dropped to 18. The last three years covered by the bibliography averaged only 12 articles. Two factors which explain this great drop are (*a*) the interruption caused by the outbreak of war, and (*b*) the fact that some aspects of cavitation information were recognized as having military value and were withheld from publication.

Source and Scope of Publications

Eighty per cent of all articles originated in the United States, United Kingdom, Germany, and Switzerland. Of this group 20 per cent are from the United Kingdom, and 40 per cent from the United States. The United Kingdom showed the greatest early activity. Indeed, the first article published in the United States was in 1899. Up to 1920 the United Kingdom published more articles on cavitation than the combined output of the other countries.

Two other classifications are interesting: [1] Subject, i.e., cavitation process, effects of cavitation on performance, and damage; [2] approach, i.e., theory, description, and experiment. For these classifications the listings exceed the number of articles, since many articles contain more than one subject or approach. The interest in subject matters, as indicated by the number of articles, is (*a*) cavitation process 211, (*b*) performance effects 490, (*c*) damage 273. From the viewpoint of approach the totals are (*a*) theory 252, (*b*) description 235, experiments 487. Two facts stand out; the interest in performance effects is equal to the combined interest in the cavitation process and in damage; interest in the experimental approach is equal to the combined interest in theory and description. Interest in both the cavitation process and effects on performance developed as soon as the phenomenon was recognized; whereas damage is hardly mentioned before the twentieth century.

Mechanics of Cavitation

An attempt will be made to evaluate the present state of knowledge in different areas of the cavitation field and to outline some of the more important problems for future investigation. It should be understood that this does not purport to be a consensus of the workers now active in the field but is simply an expression of the current opinion of the author.

It is now generally recognized that cavitation is a dynamic process involving the formation and collapse of vapor-filled cavities in a flowing liquid. With normal liquids, these cavities form where the local pressure would drop below vapor pressure if the cavity did not form. Conversely, collapse commences when a vapor cavity is transported to a region where the pressure is above vapor pressure. There are several characteristic types of cavitation. In one common type the cavity remains fixed with respect to the boundary surface. The liquid-vapor interface is very active, with material interchange between the two phases, presumably with vaporization in the upstream regions and condensation toward the downstream end. There is physical entrainment varying from a smooth, fine-grained process to a violent large-scale process in which a major fraction of the cavity may be suddenly swept away, followed by regrowth and resumption of entrainment. There is a relatively rapid circulation within the cavity, induced by the flowing liquid.

In another distinctive type of cavitation, discrete traveling cavities are formed. They move with the local liquid velocity. Such cavities have been studied in detail (2) for cases in which the pressure distribution in the noncavitating flow is known. The cavity first appears where the pressure drops to vapor pressure. It grows as long as the pressure is at or below vapor pressure, and starts to collapse as the pressure becomes greater than vapor pressure. Experimental measurements of the time rates of growth and collapse of such isolated spherical cavities agree well with the behavior predicted by Rayleigh (3). Deviations are in the direction to be expected from the idealized boundary condition used by Rayleigh, e.g., nonviscous incompressible liquid, completely empty cavity. In this type of cavitation, as the intensity is increased, the number of cavities per unit area increases rapidly until there is interference between them. During the growth period two or more may coalesce, and in the collapse zone they often collapse in tandem; i.e., the first in a series collapses into the second, and so on. Although such interference makes analysis impossible, it is obvious that the general mechanics is the same as that for the solitary traveling spherical void.

Another distinctive type of cavitation has been observed so frequently at the tips of propeller blades that it is called "tip" cavitation. The cavity forms in the core of a vortex and appears as a long small-diameter tube. On revolving propellers these tubes appear as helices. They trace the path of the propeller tips relative to the liquid and hence do not conform with the flow lines of the liquid.

Occasionally other apparent types of cavitation have been observed. Usually a little study shows that they are combinations of the three types just described.

Effects of Liquid Properties on Cavitation

The pressure relations just described are typical of cavitation in normal liquids, and in relatively large-scale installations such as pumps, turbines, or field structures, in general. However, under some conditions the properties of the liquid may affect the cavitation parameter[2] for incipient cavitation and possibly influence the type of cavitation. These properties fall into two groups: (*a*) Those of the pure liquid, and (*b*) the effect of impurities. In bubble or void formation in a pure liquid, the first property that must be considered is tensile strength. It is commonly assumed that liquids have no tensile strength and yet both theory and experiment agree that pure homogeneous liquids have high tensile strength, tens of atmospheres or higher. If the tensile strength is effective, it will decrease the K for incipient cavitation. If the liquid shows little or no tensile strength, there must be flaws in the liquid, due either to the presence of impurities or to holes in the liquid structure itself. The possibilities of the latter are determined by the molecular structure of the liquid. Current theories indicate that the probable number of holes per unit volume is far too small to explain the observed cavitation characteristics. This tends to focus attention on the impurities.

[2] The cavitation parameter is

$$K = (p_L - p_c) \Big/ \left(\rho \frac{V^2}{2}\right)$$

where p_L is the pressure in the undisturbed liquid, p_c the pressure within the cavity (usually the vapor pressure), V the relative velocity, and ρ the liquid density.

The effects of impurities in producing weak spots have not been explored completely. However, some general remarks can be made. If the impurities are completely dissolved gases, there is good experimental evidence (4) to show that they have little practical effect. For example, water saturated with air at atmospheric pressure exhibited a tensile strength of approximately 500 psi when all of the air was completely dissolved. Conversely, gases present in the gaseous phase, e.g., bubbles, are obvious flaws in the liquid since they supply gas-liquid interfaces and thus reduce the apparent tensile strength of the liquid to zero. If the impurity is a completely miscible liquid, it would appear to be comparable to a completely dissolved gas. If the impurity is a dissolved solid, it could be expected to fall in the same category as a dissolved gas or a miscible liquid and presumably would have little effect on the cavitation properties of the solvent. If the impurity is an insoluble solid, then each solid-liquid interface is a flaw whose relative weakness depends upon such properties as wettability, bond strength, size, shape, and so on.

Once a tiny cavity is formed, it is clear that the thermodynamic properties of the liquid (latent heat, specific heat, and heat conductivity) will affect the rate of growth of this cavity. It should be noted that the growing interest in the properties of the liquid and its impurities is not merely academic, since these factors seem the most likely ones to explain both the differences in cavitation behavior shown by different liquids and the cavitation "scale effect" whose existence is becoming recognized.

Effects of Cavitation on Performance

Like many other aspects of cavitation, its effects on the performance of hydraulic devices have long been recognized but only partially understood.

These effects manifest themselves in at least three different ways:

(*a*) *An Increase in Resistance to Flow.* In pumps this effect may appear as an increase in power requirements. In turbines it may manifest itself as a drop in power output for a given head and flow rate. One possible explanation of this increase in resistance is that it is the net result of two opposing factors, a decrease in skin friction on the surface covered by voids and an increase of form resistance as the effective shape of the surface is changed by the presence of the voids. Thus in some hydraulic machines a slight increase in efficiency has been observed at the inception of cavitation, followed by a drop as cavitation develops. This implies that in the early stages, the decrease of friction more than balanced the increase in form drag.

(*b*) *A Major Change in or a Breakdown of Flow Pattern.* This effect manifests itself as an upper limit of the flow rate irrespective of an increase in the pressure drop which causes the flow.

(*c*) *Development of Vibration.* The "spoiling" of the flow by the presence of cavitation frequently manifests itself in premature separation, the formation of Kármán vortex-streets, and similar pulsating-flow phenomena.

Mechanics of Cavitation Damage

In this phase of the cavitation phenomenon there is more speculation than knowledge. One basic reason for this is that since cavitation damage is caused by the cavitation process, it is extremely difficult to understand the mechanics of cavitation damage without first understanding the mechanics of the cavitation process. Thus it is little wonder that this field is still largely unexplored. However, some landmarks have been charted by the individuals who have ventured into this area.

(*a*) Cavitation can damage solids by purely mechanical processes under conditions in which chemical action is impossible. For example, glass, quartz, stainless steel, stellite, gold are damaged by cavitation in pure water. Metallographic studies show clearly that metal surfaces damaged by cavitation show evidence of mechanical working.

(*b*) In many cases cavitation seems to stimulate corrosion. Experiments indicate a critical intensity of cavitation for each material below which little or no detectable damage occurs. Above this intensity threshold, the rate of damage increases with the intensity. The situation for corrosion is similar; i.e., a given material may resist the action of given acids or salts if their concentration remains below the threshold values; whereas, if concentrations are increased above these values, appreciable corrosion damage may result. However, the combined effect of cavitation plus corrosion may produce damage under conditions in which either one acting alone does not. It is the author's opinion that this possibility of combining effects is responsible for some of the confusion now existing in the literature on cavitation damage.

Relative Resistance of Construction Materials to Damage by Cavitation

In this phase of cavitation there is much empirical information. Some of it is direct observations of various materials under cavitating conditions in hydraulic structures and machines. The material may be either an integral part of the equipment, or applied as a protective overlay. Many publications discuss the merits of different methods of application of the protective layer and evaluate the relative resistance of different materials. The consensus is that the best resistance to cavitation damage is exhibited by hard materials with high elastic and corrosion limits, e.g., stainless steel and stellite.

Rubber is an interesting exception. In some equipment a layer of rubber, properly cemented or vulcanized, shows practically no damage under conditions which damaged the metal surface. However, if the intensity of cavitation is increased above some critical value, the rubber protective layer is destroyed rapidly, usually coming off in large units, and an examination shows evidences of high internal temperatures. This is consistent with the concept that cavitation damage occurs by mechanical working. Since rubber has relatively high hysteresis and low heat conductivity, its internal temperature should rise under the effect of cavitation, and if the energy dissipated through hysteresis becomes great enough, its temperature rise could produce physical damage.

Many attempts have been made to classify the resistance of materials by means of laboratory tests. In this country the most used is the magnetostriction method. In Europe the impingement of a stream of individual drops of test liquid also has been widely used. The relative resistances found by different methods do not

always agree nor do the results of field use necessarily rank the material in the same order of merit. There are many possible reasons for these discrepancies. There is no conclusive evidence that laboratory tests actually simulate damaging conditions in field structures and machines. Also, it is not certain what are the significant parameters in these tests, e.g., surface finish and intensity of the cavitation. In the author's opinion the latter is a fruitful source of difficulty.

The normal magnetostriction technique is to establish a given frequency and amplitude of vibration of the specimen and to observe the loss of weight as a function of time. Hence, if this test does produce conditions that are typical of cavitation, they are certainly only of cavitation at one given intensity. As previously stated, there is evidence that different materials have different damage thresholds; however, little is known about the behavior of materials having the same damage threshold. Thus it would be desirable to make tests of the materials at the cavitation intensities encountered in the application under consideration. However, at this point the investigator finds himself on the brink of an abyss gazing out over completely unknown territory, since no satisfactory method has been developed for measuring the absolute intensity of cavitation, either in the laboratory or in the field.

Cavitation "Scale Effect"

A common question regarding laboratory studies is, how can the results be extrapolated to the field conditions for larger sizes and powers? If these studies have developed a basic understanding of the mechanics of the phenomenon, the answer is quite definite. Until this goal has been reached it may be very difficult to predict the scale effect. This is the present case for many hydrodynamic phenomena, including cavitation. It is often assumed that geometrically similar models and prototypes will have the same cavitation performance when operating at the same cavitation parameter K. Since K involves only pressures and velocities, this is equivalent to assuming that cavitation is independent of size.

However, recent investigations indicate that a change in size does affect cavitation even within the relatively small variations possible with laboratory equipment. Also there is good evidence that the properties of the liquid and its *undissolved* impurities play a significant role in its cavitation performance, but as yet little has been done to control these properties other than to maintain a relatively constant temperature and *dissolved* gas content.

Laboratory evidences of scale effect have all been consistent, i.e., a suppression of cavitation until after the local pressure has dropped below the vapor pressure. This means that under some conditions liquids have an effective tensile strength. This appears to increase as either size or velocity decreases. From such evidence the author has concluded tentatively that for a given set of liquid conditions the significant parameters are size and shape of the test body and velocity of flow, since these determine the intensity and duration of the tensile stress to which the liquid is subjected before cavitation begins; and that the depression, ΔK, of the incipient cavitation parameter below the value computed on the basis of zero tensile strength is a measure of their combined effects. It is believed that probably some relationship, $f(v, d, \Delta K) = \text{const}$, exists. Such a relationship, if it could be found and verified both experimentally and analytically, would give a direct method of computing scale effect.

Needs for Future Work

It is always dangerous to attempt to peer into the future and to make predictions as to what will take place. Therefore the author will content himself with a brief estimate of some of the urgent needs for additional information.

The most important immediate need is for more detailed study of the mechanics of cavitation, in particular that of the "fixed" type cavity. Such a study is inherently involved with the physical properties of liquids and their normal impurities.

Next would come the investigation of the mechanics of cavitation damage. This does not imply secondary importance but reflects the fact that progress here must wait further clarification of the mechanics of the cavitation process.

It is believed that the most serious lacks in our knowledge of the effects of cavitation on performance are a quantitative understanding of the mechanics of the increased resistance to flow produced by cavitation, and the location and extent of various types of cavitation which occur in hydraulic machines, and the effects of changes in operating conditions on these quantities.

Future work on the relative resistance of material to damage should be correlated with studies of the mechanics of damage. An important step would be the development of a definition of intensity of cavitation and some rational measure of it which could be used both in hydraulic machines and structures and in equipment employed for determining relative resistance.

In the study of scale effect, additional carefully controlled experiments would be valuable as the amount of information now available is too meager and limited in scope even to outline the field. In this field scrupulous attention must be given to secure exact geometric similarity if valid results are to be obtained. It is anticipated that the analysis of the results in this field will be greatly assisted by any increase in our understanding of the mechanics of cavitation.

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Manufacturing Methods of Power-Transmission Gears and Their Influence on Design Considerations

This paper deals with the various processes for manufacturing gears and analyzes the differences in results achieved

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CALCULATION of power capacity of gears usually is based on the following three major limitations:

1 Static strength of gear teeth, determined by the operating bending stress in the root, and the permissible bending stress of the tooth material in this location.

2 Surface stress at the tooth flanks in mesh, and the ability of the material to resist scuffing, pitting, or plastic flow under the surface stress and sliding velocity involved.

3 Rate of heat generation and ability of gears and cooling lubricant to dissipate heat at a temperature that will not favor deterioration of the material under surface stress and sliding velocity.

Calculation is based on assumptions which deviate from actual conditions. Linear increase of stress from neutral zone to maximum at surface is generally not existent on an actual gear tooth. Stress concentration at the root fillet is affected by manufacturing processes. The surface of a carburized gear has an initial compressive stress which counteracts the operational tensile stress.

Resistance of the surface of tooth flanks against deterioration depends on the initial characteristics of the surface, its smoothness, ability to retain lubricant, and hardness.

Limitations due to heat generation are generally not decisive as long as pressure lubrication is adequate, and as long as progressive damage of the tooth surfaces does not occur due to insufficient physical characteristics.

Ability of the gear-tooth material to resist operating stresses is determined by physical characteristics, which, in turn, are obtained by metallurgical treatments. The designer, therefore, must be informed on the metallurgical processes that are available for manufacture of the gears.

Calculation of gear stresses is based on distribution of loads over definite areas or portions of the teeth. Accuracy of manufacture therefore must be adequate to insure contact under load, in order to actually utilize the full dimensions of the gear teeth.

Whenever the methods of obtaining optimum dimensional and physical qualities are not available, the designer must make allowances in size. Also, if the available methods cannot be controlled adequately as to final results, the design must specify sizes to suit the low limit of the expected quality range.

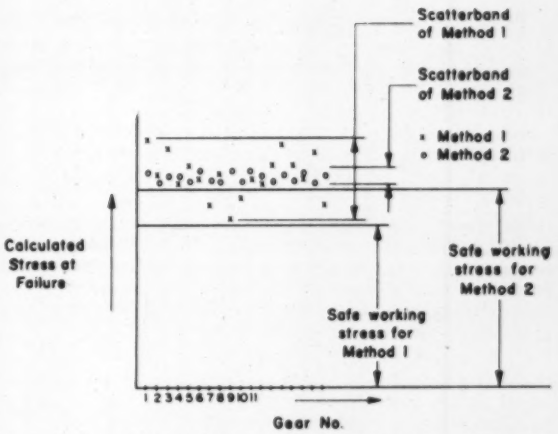
Scatterband of Method 1
Scatterband of Method 2
× Method 1
○ Method 2
Calculated Stress at Failure
Safe working stress for Method 2
Safe working stress for Method 1
1 2 3 4 5 6 7 8 9 10 11
Gear No.

Fig. 1 Hypothetical chart comparing different manufacturing methods. Method 1 gives higher maximum and higher average, but safe working stress is lower than that of Method 2.

If a large number of gears manufactured by two different methods were to be tested to failure, the method giving highest individual results would not necessarily be preferable. A narrow scatterband of results indicating more uniform results would give the advantage of providing a reliable safe working stress, Fig. 1.

Physical and dimensional characteristics are interrelated. The heat-treating methods which produce the desired physical properties of the gear teeth always have the detrimental effect of producing distortions. Distortions occur within the gear teeth as well as within the blank, resulting in deformed teeth, unequal spacing, and ovality and eccentricity of the pitch diameter.

In operation, this means localized concentrated tooth loads, periodically changing loads due to accelerations in the rotating motion, and fluctuations of reaction forces on bearings and structures. The resulting increased stresses correspond to reduction of power capacity.

Improving Physical Properties

The following processes are available for improving physical properties of gears:

Contributed by the Machine Design Division and presented at the Semi-Annual Meeting, Pittsburgh, Pa., June 20–24, 1954, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. (Condensed from ASME Paper No. 54—SA-19.)

1 Heat-treating or hardening of the entire gear. This will increase tensile and compressive strength and wear resistance of the tooth surface.

2 Hardening of only the surface of the gear teeth by a controlled heating process. Typical examples of this method are induction-hardening and flame-hardening.

3 Surface-hardening by chemical changes of the surface. The principle of these processes is the use of a grade of steel which normally will not become fully hard, but by application of suitable processes the surface is chemically changed to assume hardenability. Processes of this type are carburizing and nitriding.

4 Cold-working of the surface. This process imparts a compressive stress to the surface by mechanical pressure exceeding the yield point. The practical method is shotpeening.

Comparison of Gears Made by Different Processes

Table 1 compares physical data of gears made by different processes. The numerical values in this table should be taken only as typical, not as definite limits. The important difference is in the allowable stresses which determine the size of the gears.

Fig. 2 is a diagram explaining the superior qualities of the carburized gear. At the outer fiber, where maximum calculated tensile stress occurs, the strength of the material is highest, and also, the material is under a compressive stress which counteracts the working stress.

Fig. 3 compares a heat-treated gear set with cut teeth for a naval vessel with a carburized set with ground teeth. Center distances, in this case, were fixed, so the entire saving was taken in face width. The cut gears have an over-all width of 34 in., versus 13.8 in. for the carburized and ground gears. Helix angle on the new gear set is held low enough to keep end thrust at small values suitable for the shoulders of the bearings, yet sufficient to obtain tooth overlap.

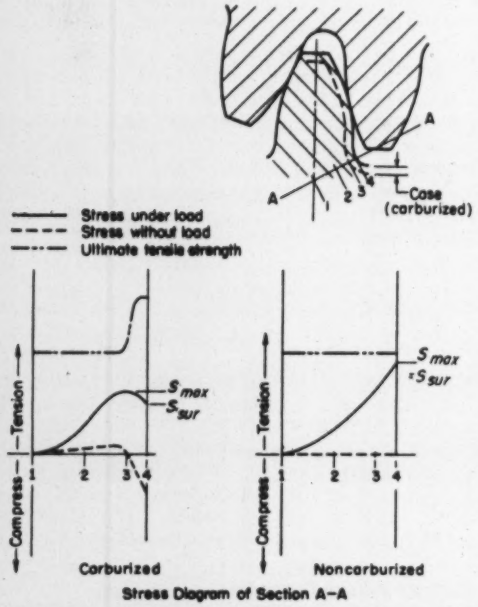

Fig. 2 Diagram showing stress difference between carburized and noncarburized gears

Table 1 Physical Characteristics of Gears Made by Different Processes

	Soft	Heat-treated	Induction or flame-hardened	Carburized or nitrided
Core hardness, Bhn (Rockwell C).....	190 14	250 26	280 30	330 35
Case hardness (Rockwell C)....	14	26	55	60
Tensile strength at outer fiber, psi..	90,000	125,000	250,000	300,000
Typical allowable bending stress, psi.....	15,000	20,000	28,000	40,000
Typical allowable surface compression stress, psi..	75,000	90,000	135,000	160,000
Reliable maximum operating pitch-line velocity, fpm.....	5,000	20,000	30,000	40,000

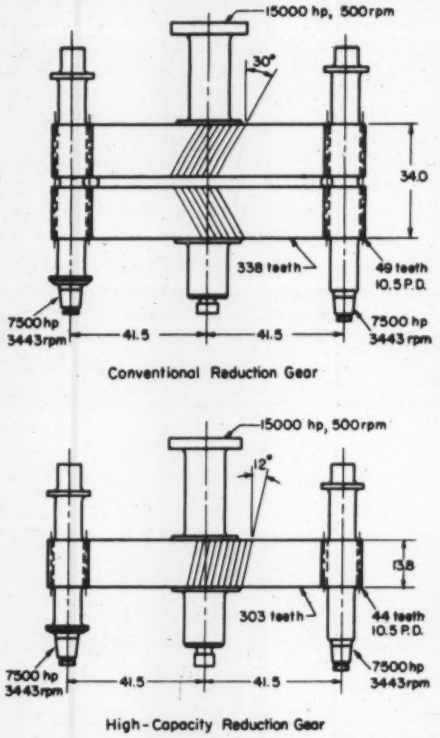

Fig. 3 Comparative data for a conventionally designed heat-treated gear set and an equivalent redesigned high-capacity carburized reduction-gear set

Carburizing distortions depend on material and processes used. By proper selection of the steel, and by quenching in rigid fixtures, distortions can be reduced. Tests with careful control of heat cycles may provide a means for finding the best, i.e., least distorting, hardening procedure for a gear, and thus may permit production of some gears to acceptable accuracy without grinding. However, this process usually will have only limited applications, as one certain heat cycle may work well on one gear, but be different in its effect on gears

of different size or shape, or it may even vary from one batch of steel to another.

Generally, it is found that the good results of one carefully devised heat cycle are hard to duplicate whenever any change, however insignificant, is introduced. Such changes may occur in the timing of heating and cooling, in the transfer from furnace to quenching bath, and similar handling procedures. The increased cost of elaborate heat-treating control is usually much higher than the cost of finish-grinding.

Cost of Ground Versus Cut Gears

Where costs of ground gears versus cut gears are compared, the complete design from the initial concept must be taken into consideration. The cut gears will, of course, eliminate the cost of carburizing and grinding. However, cut gears will be considerably larger. This will mean greater cutting cost. For final surface finish and tooth form, a shaving operation usually will have to be performed. The housing and bearing structure will be more expensive, owing to the increased dimensions, and also assembly, shipping, and installation. In many cases, the dimensions of the gear case may limit the design of prime mover and driven machine.

The carburized and ground gear may be designed with considerably smaller dimensions, and thus the entire drive will have the economic advantage of a more compact and light unit. Machining cost will be saved on all parts of the drive assembly, cutting cost of the gear teeth will be lower, and shaving is eliminated. Carburizing and tooth grinding are the only important additions, but they are likely to be more than compensated for by the savings in material, machining time, and easier handling.

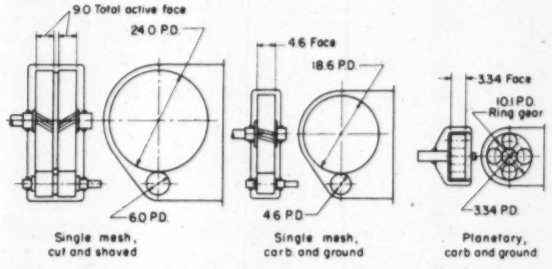

Fig. 4 Comparison of gear dimensions for 1000 hp, 2000 rpm, 4:1 gear ratio—single-mesh versus planetary drive

	PLANETARY Carburized & Ground Spur			PLANETARY Carburized & Ground Helical			SINGLE STAGE Carburized & Ground Spur			SINGLE STAGE Carburized & Ground Helical			SINGLE STAGE Cut Helical		
F/D	D_g	D_a	F	D_g	D_a	F	D_p	L	F	D_p	L	F	D_p	L	F
1/2	4.75	14.25	2.38	4.2	12.6	2.10	6.60	33.0	3.30	5.86	29.20	2.90	6.62	43.10	4.31
1	3.77	11.30	3.80	3.34	10.10	3.34	5.24	26.2	5.24	4.64	23.20	4.64	6.84	34.2	6.84
3/2	3.30	9.90	5.00	2.90	8.70	4.35	4.58	22.9	6.87	4.06	20.30	6.10	6.00	30.0	9.00

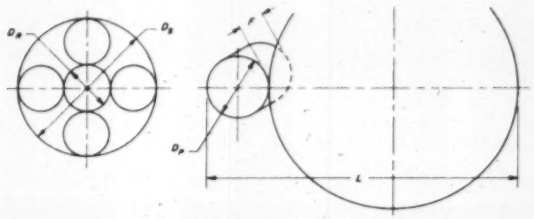

Fig. 5 Table for comparing gear-drive dimensional data

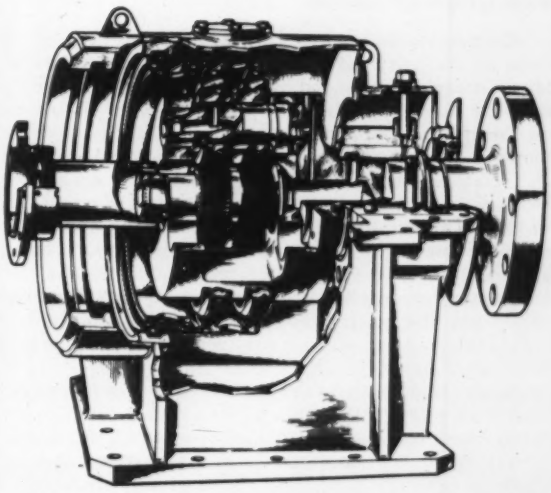

Fig. 6 Large planetary-reduction gear set. Courtesy of High Precision Products Company.

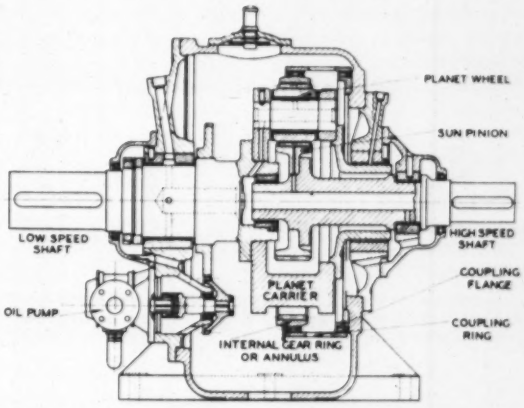

Fig. 7 Large self-contained planetary gear with 3:1 ratio. Courtesy of High Precision Products Company.

Reduction in Dimensions

Reduction of over-all dimensions is obtained in planetary drives. Fig. 4 shows the comparison of sizes of single-mesh versus planetary drive. For an input speed of 2000 rpm, 1000 hp, and 4:1 gear ratio, a single-mesh pinion, carburized and ground, would have a pitch diameter of 6.6 in. and face width of 3.3 in. For a planetary with four pinions, it would be 4.75 in. with a face width of 2.38 in. The table in Fig. 5 shows a comparison of the dimensional data.

High-power planetary reduction gears are presently used and under development. Existing units operate at several thousand horsepower, with input speeds up to 25,000 rpm. Figs. 6 and 7 show large planetary reduction gears. This design has been made in power ratings of 20,000 hp, with input speeds up to 30,000 rpm. Characteristic is the full-floating internal gear, which permits it to align itself with the planets.

Manufacturing Processes

Manufacture of cut gears for high-power capacity is done on conventional gear-hobbing machines. Available accuracy is determined by the worm and gear which turn the large gear blank, by the rigidity of the cutter mounting, and the uniformity of the hardness of the blank. The large forces occurring during cutting, and the resulting deflections of blank and tool, with their mountings, will affect surface finish of the cut teeth and, in case of nonuniform hardness, the spacing and tooth form. Subsequent shaving will improve surface finish and tooth form but will not correct spacing errors.

Grinding of gear teeth will permit correction of virtually any discrepancy produced in cutting and hardening, if the grinding process is done in a manner that will not reflect grinding-wheel wear into the gear teeth. However, it is important to use a type of grinding wheel that is subjected to continuous and rather rapid wear. If the wheel is of the hard-bonded type which wears only slowly, then the same grit will come in contact repeatedly with the work, and the originally sharp edges of the grit will be dulled. Then the grinding wheel will rub on the surface of the teeth, producing friction and high surface temperatures. The sharper the grit of the grinding wheel, and the smaller the contact area between grinding wheel and gear teeth, the less will be the heat generation.

Processes like form-grinding, Fig. 8, or generating

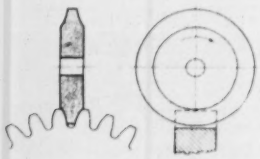

Fig. 8 Formed-wheel gear-tooth grinding

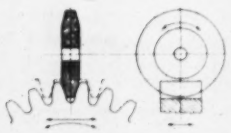

Fig. 9 Gear-tooth generating grinding with straight-contour wheel

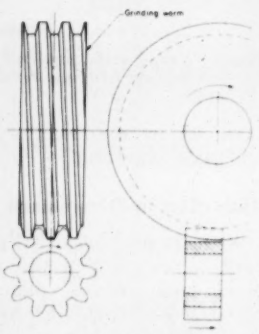

Fig. 10 Gear grinding with worm-type wheel

with a straight-sided wheel, Figs. 9 and 10, will give good results only on small gears, and with application of ample liquid coolant. On gears having large numbers of teeth, grinding-wheel wear in these processes would result in errors in tooth form and spacing. If wheel wear is reduced by use of hard-bonded wheels, then the danger of overheating becomes acute.

Overheating during grinding would lead to softening of the carburized surface and to tensile-stress areas on the tooth flanks. If grinding extends into the roots, this area would be sensitive to grinding burns. Gears that were ground by one of the foregoing processes should be checked for grinding burns by applying a mixture of alcohol and nitric acid (nital test) which produces dark discoloration on areas overheated during grinding.

Special Grinding Machines

A process that permits continuous grinding-wheel wear together with smallest contact areas, is shown in Fig. 11. In this process the grinding wheel touches

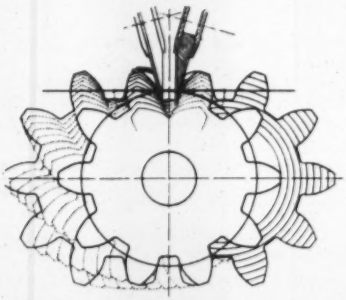

Fig. 11 Gear-tooth point-generating grinding process

Fig. 12 Maag gear-tooth grinding machine for pitch diameters to 142 in.

the gear teeth only in two points, at the thin outer edge of the wheel. The latter is of the soft-bonded type which breaks down fast and brings new sharp grit into operation. The wear of the wheel is compensated automatically. A flat diamond touches the edge of the wheel every few seconds, and if the edge has worn more than a preset amount (0.00004 in.) the wheel is readjusted automatically to the original position. Thus any number of teeth on gears of any size may be ground uniformly within the capacity of the machine.

Fig. 12 shows a Maag gear-grinding machine for pitch diameters up to 142 in. On these large machines the gear is arranged vertically, and the grinding slide moves along the face of the gear, while the latter rotates in proper relationship to the lateral motion of the grinding slide, generating the involute. Smaller gear grinders are designed for horizontal arrangement of the gear axis, with stationary grinding-wheel supports; all generating and feed motions are performed by the gear.

Bearings, Lubricants, and Lubrication

A Digest of 1953 Literature[1,2]

Journal Bearings and Bearing Materials

DuBois and Ocvirk (1)[3] carried out an experimental investigation of the performance of a full journal bearing under steady load for various ratios of length to diameter. Eccentricity ratios, friction, and oil-flow data were obtained and compared with theoretical calculations. The average change in the oil-film thickness in the bearings of a rolling mill during periods of acceleration and deceleration has been measured by Sims (2). Stephan (3) has calculated the pressure, coefficient of friction, oil flow, and mean temperature in a high-speed cylindrical sleeve bearing and has compared the results with experiment. Numerous graphs are given for various operating conditions.

McBroom (4) has shown experimentally that cavitation exists in the divergent part of an oil film in a sleeve bearing and has found that pressure conditions postulated in some recent theoretical analyses are not confirmed by experiment. An experimental study by Sines (5) of the lubrication of a miniature turbine rotor on porous bushings has indicated that different mechanisms of lubrication prevail at various speeds ranging from 0 to 60,000 rpm.

Slaymaker (6) develops a simplified bearing design based on concentric journal theory. This enables him to draw conclusions of a general nature about problems which because of uncertainties in the control of the variables or for other reasons are too complex to analyze. An approximate solution for a short full-journal bearing was developed by Ocvirk (7), who compares calculated results with experiment. Good agreement is obtained for length-diameter ratios of $^1/_4$, $^1/_2$, and 1.

Blok and Van Rossum (8) have considered a bearing which is devoid of rigidity, an example of which is an extremely flexible foil which is stretched around a journal. They find that the oil film which forms has parallel surfaces; along the whole length of the film constant pressure is formed. Side leakage was shown to be negligible.

Lunn (9) has reviewed briefly the development of the science of hydrodynamic and boundary lubrication and concentrates on the interaction between bearing material and lubricant. See reference (135) for more complete treatment of this subject by the same author. Mechanical and metallurgical properties of the aluminum-base bearing-metal alloy K-4, along with service data in comparison with other bearing materials, are reported by Rohenbeck (10). Collari and Paglialunga (11) describe results of Amsler wear tests on a number of aluminum-base bearing metals. These alloys, principally aluminum with tin, titanium, and copper, showed great reduction of wear over lead bronze when tested against steel.

Ball and Roller Bearings

In an angular-contact ball bearing, couples exerted on the balls by the tracks can cause oscillations of the balls leading to premature fatigue failure. Frenkel (12) has developed criteria analytically for constructing bearings free from oscillations over certain ranges of speed and load. Getzlaff (13) has tested small ball and roller bearings at speeds ranging from 20,000 to 70,000 rpm. Effects of speed, oil flow, cage material, and clearance on bearing temperature are treated. The effect of clearance on the dynamic capacity of rolling-contact bearings is discussed by Lundberg (14), who finds that increased clearance generally is detrimental to radial capacity, but, for ball bearings, is beneficial to axial capacity. Lundberg and Palmgren (15) have republished their thorough analysis of the life of roller bearings. Their correlations can be used to predict the life of roller bearings under different loading conditions.

Johnson, Swikert, and Bisson (16) have measured wear and friction of several nickel alloys sliding against SAE 52100 steel at 5000 fpm. Those alloys forming oxide surface films during sliding gave the best results and might serve as cage materials for high-temperature, high-speed bearings. High-temperature ball bearings lubricated with silicone oil-lithium soap greases have been found to be much more sensitive to clearance than are bearings lubricated with organic oil-metal soap greases. Grant (17) concludes that the former greases are thermally stable but cannot withstand extreme loads, while the latter greases break down thermally to give a consistent short life, regardless of load. A comprehensive review of ball-bearing greases or extreme temperatures is presented by Oliver (18) who correlates results from several governmental and industrial sources.

The effects of oil flow, speed, and load on the temperature of deep-groove ball bearings have been studied experimentally by Nemeth, Macks, and Anderson (19). The lowest temperatures were obtained when the oil was directed between cage and inner race. They established for these bearings a correlation (20) whereby bearing temperature or power rejected to the oil can be predicted over a wide range of operating conditions. The same authors (21) compared the performance of ex-

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[1] Report prepared by Dr. J. C. Geniesse and H. A. Hartung with the assistance of the ASME Research Committee on Lubrication. Contributing committee members were: J. C. Geniesse, M. D. Hersey, C. M. Larson, S. J. Needs, B. G. Rightmire, E. Saibel, and S. K. Talley. The summary for the year 1953 was based on the Engineering Index references on Bearings and Lubrication.

[2] The digest of 1952 Literature appeared in MECHANICAL ENGINEERING, vol. 75, October, 1953, pp. 801–808.

[3] Numbers in parentheses refer to the Bibliography at the end of the paper.

perimental and conventional roller bearings at high speeds. An experimental bearing with cage riding the outer race and rollers guided by the inner race gave the best results, since it was more readily lubricated than the other types tested. In another investigation by these authors (22) bronze and nodular iron as cage materials for roller bearings at high speeds were studied. They suggest that the high wear obtained with a nodular-iron cage results from cage slip, produced by the high friction of this material on SAE 52100 steel. Macks and Nemeth (23) have set up a method facilitating prediction of operating temperatures of certain roller bearings. This same subject is discussed further by Anderson and Macks (24).

Radzimovsky (25) has proposed a method of calculating the surface endurance limit for two cylinders rolling together which takes into account variation in stress as a point passes through the loaded zone. This method is based on the Huber-Mises criterion generalized for variable loads. Good agreement is found between previous experimental results and the calculated ones. In an attempt to get fundamental information applicable to rolling-contact bearings, Niemann and Kraupner (26) have determined in a special test rig the effect of the following variables on plastic deformation of rollers in point contacts: number of revolutions, load, hardness, and initial profile. The surface damage also is discussed.

A new high-speed roll-neck bearing utilizing an interference fit between the cones (inner races) and the roll neck is described by Haager (27), together with hydraulic means of assembly and disassembly. Scuffing of the roll neck is reduced or eliminated by means of this arrangement. An air gage for checking diameter and taper of roll necks also is described.

Perret (28) has analyzed vibrations occurring in rolling-contact bearings for cases in which the load distribution is statically determinate. Conditions are set up that should be met in the construction and installation of bearings in order to minimize these vibrations and hence reduce the noise. In another study of noise in roller bearings, Lohmann (29) describes equipment and test methods useful in determining the sources of such noise. Errors in geometry of the bearing are related to the type of vibration or noise they produce.

The running time of a ball bearing on a small quantity of lubricating oil varies exponentially with the quantity of oil present, according to Booser and Wilcock (30). Oil films of less thickness than that required to cover the surface roughness of the bearing provide poor operation and short life. For a given quantity of oil the running life increases with increasing oil viscosity and increasing surface tension. Other factors also are correlated and discussed. Fogg and Webber (31) found that boundary-lubrication conditions predominate between balls and races in ball bearings. They studied the operations of 2-in. ball bearings in the speed range of 6000 to 30,000 rpm, varying the type and rate of lubrication, viscosity of lubricant, and variations in the type of loading.

Walker and O'Meara (32) report that five years is too long a period for electric motors in continuous service to run on a single lubrication. However, with the improvements being made in lubricants and bearings and bearing housings it is possible that such a life may be attained in the near future. Ball and roller-bearing lubricating-oil viscosities for various speed factors and temperatures are presented in plot form in "Scientific Lubrication" (33). The advantages and disadvantages of different types of grease also are detailed.

Thrust Bearings

Theoretical investigations of the Reynolds equation as applied to slider-bearing lubrication are continued by Saibel, Charnes, and Osterle. Two new cases are considered; the nonsteady-state operation of tilting-pad slider bearings (34) and the optimum slider profile for viscosity a function of the pressure (35). Thus far eight conditions have been analyzed in these studies. (See digest for 1951 and 1952.)

Results of studies on the influence of surface profile on the load capacity of thrust bearings with centrally pivoted pads are reported by Raimondi and Boyd (36). The authors conclude that the load capacity of a truly flat, centrally pivoted pad is theoretically zero when air-lubricated and they confirm this conclusion experimentally. Further, they show that if the surfaces of centrally pivoted pads are slightly convex, they will operate satisfactorily, air-lubricated, in either direction of rotation. Tests with liquid lubricants show that surface convexity, and viscosity drop with temperature, as the lubricant passes through the film, account in most part for the load-carrying capacity of centrally pivoted pads.

Charts and tables applying bearing theory to the analysis and design of thrust bearings of both fixed and pivoted-pad types have been prepared by Raimondi and Boyd (37). Illustrative problems are given in each case and comparisons are made between theory and test.

The hydrodynamic pocket bearing is described by Wilcock (38). In this bearing the pocket oil pressures are generated by movement of the runner over a converging pumping land. Preliminary operation of this type bearing has been successful and the possibility of substantial savings in power loss at high rotative speeds over conventional thrust bearings is explored.

Investigation of a Kingsbury thrust bearing using air as the lubricant has been made by McKinley (39). Some general conclusions are reached and the recommendation is made that the point of support of the thrust shoes should be located on the trailing side of the radial center line.

An analysis of the stepped thrust bearing by relaxation methods has been made by Kettleborough (40). This solution is applicable to any shape of step. Results indicate that the load capacity of the completely internal step is much greater than that of the simple tilting slider. The author states that a full experimental program is being carried out on this bearing to evaluate its practical performance characteristics.

A comparison of wedge and pressure oil lubrication is made by Leyer (41). The possibility of saving in power loss by use of the pressure-lubricated step bearing is discussed in considerable detail.

Automotive Lubricants

The factors responsible for engine wear are undergoing intensive study. Undoubtedly the development of a radioactive-tracer technique for measuring engine wear is responsible for this reawakened interest since it is much more rapid and less costly than methods previously used. Pinotti, Hull, and McLaughlin (42) describe the radioactive-piston-ring technique and show in general the effects of high-sulphur fuel, high load

and low jacket temperature in accelerating wear. Engine operating conditions, fuel and lubricating-oil quality are all shown by Jackson, Burk, Test, and Cowell (43) to influence wear rate in laboratory engines fitted with radioactive rings.

Kavanagh (44) reports data indicating good correlation between laboratory radioactive-ring wear tests and field cylinder wear. Tests described by Jackson (45) showed that laboratory radioactive ring-wear test results line up with field wear data obtained by measurement and by the use of radioactive rings. The effectiveness of heavy-duty oils in reducing wear in passenger-car engines is shown by Palmer (46); Ellis and Edgar (47) report similar wear reduction when oils of high alkalinity are used in engines running under high load, with low cylinder temperatures, or with high-sulphur fuel. Raviolo (48) points out which areas in engines require special attention in lubrication.

Kunc, McArthur, and Moody (49) report that most engine wear is due to friction and abrasion between rubbing surfaces whereas Geniesse and Jackson (50) attribute it to corrosion. Pocock (51) reports that leaded gasolines give higher wear and heavy-duty oils increase wear under some conditions and decrease it under others.

A very informative symposium on engine-testing of lubricating oils was held by the Institute of Petroleum. Kendal, et al. (52) cover such aspects as the philosophy of testing, standard laboratory tests, field tests, engine deposits and wear, used-oil analyses and statistical methods of analysis. Wilford (53) discusses passenger-bus and long-distance-freight lubricant requirements. Military requirements for test methods are brought out by Baddeley, et al. (54). Pearce (55) puts forth a diesel-engine manufacturer's thoughts on test methods, while Fogg and Oliver (56) describe test experiences with a multicylinder diesel engine. A discussion of the Caterpillar L-1 and Chevrolet L-4 test procedures is provided by Cree (57).

In this symposium Towle and Vaile (58) describe a 120-hr test in a Petter diesel engine which appears to be suitable for predicting the performance of oils in the Caterpillar L-1 test. Simmons (59) points out the information that may be obtained through the use of the Lauson gasoline engine when testing additive oils. A dual-purpose engine that can be operated either under the Otto or diesel cycle is described by Perry (60), and Bell (61) reports on a single-cylinder Petter gasoline engine with results indicating a good correlation with the Chevrolet L-4 test. Discussion of the symposium papers also offers interesting food for thought (62).

A symposium on the examination of used crankcase lubricating oils by J. B. Matthews and associates provides interesting facts for the reader who wishes to study the physical and chemical changes taking place when internal-combustion-engine oils are subjected to use. These papers present data on their composition (63), size and flocculation rating of insoluble particles (64), a study of oxidation tests and the dispersing properties of oxidation products (65), and a kinetic study of rates of formation of deterioration products and additive depletion (66).

Considerable progress has been made in the use of the electron microscope in the study of lubricant performance. Peri (67) finds that deposit formation is prevented only while large numbers of extremely small particles of detergent plus gum or resin, averaging less than 300 A, remain individually dispersed in a detergent oil. As the particles grow larger, deposition rate increases. Broughten (68) and McBrian and Atchison (69) employ the electron microscope for studying new and used oils. This method is useful for predicting operating performance through picture pattern and particle size.

A spectrographic method for determining trace metals in used engine-lubricating oils is described by Meeker and Pomatti (70). Correlating analysis with engine experience makes it possible to avoid expensive engine maintenance. Sennstrom (71) reports on the use of the spectrograph in maintaining railroad diesel engines.

Synthetic lubricants are excellent for cold-weather use in automotive engines according to Miller and Galindo (72). Polypropylene glycols with and without petroleum oils permit easy starting while giving low oil consumption because of their high viscosity index. Low pour point aids flow to the bearing surfaces.

Shea and Ayton (73) have prepared a bibliography of 1938–1950 literature on the effect of antifreeze, batteries, starters, fuels, and lubricants on the starting and operation of diesel engines at temperatures below —20 F. Abstracts of all references are included, 345 in number.

Gear Lubrication

Gear calculations and experiments are described by Heidebroek (74) amplifying his report of the work at Dresden reviewed a year ago.[2] The influence of the lubricant on the load capacity and wear of gear teeth was investigated and the results are shown by diagrams.

Borsoff, Cook, and Otvos (75) show how the effectiveness of lubricants can be determined from wear data on gear teeth, using a radioactive-tracer technique. Tooth wear is continuously studied by measuring the change in activity of the lubricant, while it circulates through a gear box in which one of the mating gears has been made artificially radoactive. Curves for total wear in milligrams of active iron are plotted against tooth load for different oils. The apparatus is calibrated by means of a radioactive solution containing a known amount of iron naphthenate in oil.

Lane and Hughes (76) measured the electrical resistance between meshing teeth of rotating gears, using a cathode-ray oscillograph. The variation of resistance depends upon the tooth load. It was found that the resistance is always lowest where the sliding speed is highest. The resistance has its maximum value in the neighborhood of the pitch line, where there is no sliding motion.

In his second ASTM paper on the test machine for gear lubricants, Ryder (77) describes improvements in the lubricating system for the bearings and as tandardized test procedure. Photographs show the installation of a microscope and viewing light, also a typical scuffed area. To determine the scuff load, a plot is made showing the percentage of tooth area scuffed against the hydraulic loading pressure in pounds per square inch. After drawing a smooth curve the scuff is taken as that corresponding to 22.5 per cent of the total tooth height. The final scuff load for each oil in pounds per inch is equal to the foregoing loading pressure times a constant, divided by the tooth width.

Their own investigations of gear scuffing and gear wear are well summarized by Borsoff and Sorem (78),

preceded by a concise review of the history of research on gear lubrication. The conclusion is reached that gears lubricated with straight mineral oils operate under thick-film lubrication up to the scuff load (or "score load"). Beyond that point EP agents are required and act by means of chemically adsorbed films. Replying to the discussion, the authors report that polar additives alone contribute very little to the load capacity of gear teeth compared with chemically active EP agents.

In their paper on mechanical testing of gear lubricants, Hughes and Tourret (79) describe the Thornton high-speed gear-test rig, with photographs of scuffed teeth and curves showing scuff load diminishing with increasing pinion speed. Load capacity varies inversely as the $^2/_3$ power of the speed. The comparative rating of different additives remains the same at all speeds. The results are shown to agree with Blok's hypothesis that any oil breaks down when a characteristic critical temperature is reached. This paper concludes with a report on the cam-scuffing rig, a simpler device of some value offering good correlation with the gear rig.

In his study of the scoring phenomena of gears, Kelley (80) describes further investigations using a gear-test rig with different lubricants. He gives an understandable mathematical review of Blok's theory of flash temperatures at tooth surfaces. Kelley concludes that the weight of evidence favors Blok's hypothesis of critical temperatures for film failure.

Ryder claims satisfactory correlation between the indications of gear scuffing in his test rig (81) and aircraft service performance. In the discussion, Bedell advocated the use of a reference oil. Simon reported much higher load capacities in a gear rig fitted with a flexible quill shaft and other improvements. In line with conclusions by Kelley, Simon proposed that scuffing tendency be measured in terms of temperature rather than tooth load.

Borsoff and Younger (82) review the investigations on gear scuffing, metal transfer and wear previously reported by their organization. They find confirmation of the conclusion that hydrodynamic films persist until scoring or scuffing begins. With the higher-sulphur oils, the scuff load increases with increase in oil temperature, but with low sulphur it decreases. The effect of increasing viscosity in diminishing the amount of metal transfer is plainly shown by radiographs. Absence of wear below the critical scuff load was shown by the tracer technique. Wear is reduced as viscosity increases, while oil compounded with an EP agent shows practically no wear up to a very high load. Confirmatory data from two other laboratories are plotted on the curve for load capacity against the product of viscosity and speed. An EP lubricant can serve to protect the gear against scoring at peak loads, while permitting hydrodynamic operation under normal loads.

Black and Havely (83) review the different categories of additives with special reference to antiwear lubricants. They explain the action of such additives by chemical polishing, which increases the true area of contact. Typical four-ball test results are charted showing the variation of scar diameter with additive concentration for three additives. The additive selected for use in a turbine oil not only met the antiwear and compatibility requirements, but raised the load capacity of 2190 T oil about 50 per cent. The authors report that the usefulness of antiwear turbine oils has been demonstrated by full-scale tests, but that they are expected to have little effect on reducing pitting.

Johnson and Craine (84) review causes for gear failures and illustrate examples of various types.

Metalworking Lubrication

In the general field of lubrication in metalworking, metal cutting continued to receive the major research effort in 1953 and advances were made in evaluation testing, problem analysis, lubricant formulation, and mode of application.

In the first category Oathout, Howell, Hamer, and Leland (85) refined the standard single-point tool-life test by correcting for variations in the machinability of the workpiece. Reproducibility was excellent and corresponding ratings were obtained in the laboratory and in commercial operations for a number of fluids. The commercial operations are well authenticated and are described in detail. Cutting speed in the laboratory test was adjusted to give tool lives of the order of 1 to 15 minutes with annealed SAE 4140 and SAE 4340 steels.

Lauterbach and Ratzel (86) used a planing action and evaluated cutting fluids in terms of a "critical rake angle" (CRA) of the tool. The CRA is defined as the rake angle at which the surface of the chip and workpiece changes from smooth to rough. The CRA ranged from 5 deg for a highly compounded oil to 20 deg for plain mineral oil, when cutting SAE 1025 steel at 0.002-in. depth of cut and a 2.5 fpm cutting speed. Dry cutting gave 26 deg. Although their cutting speeds were limited to less than 20 fpm, a series of oil-base cutting fluids were rated in the sequence of general field experience. An important conclusion of their work is that the CRA represents an invariant condition characteristic of the workpiece and mechanical conditions of cutting. In a previous article (87), the same authors discuss the effect of cutting conditions and of cutting fluid on depth of cold work as determined by grain distortion of annealed low-carbon steel.

Stokely (88), investigating the drill for evaluating cutting fluids, found the most useful criterion was the speed at which the torque showed a sharp increase. With careful metallurgical control of the work material, the test proved reliable for formulating and testing both water-base and oil-base cutting fluids.

Beaubien and Cattaneo (89, 90) have analyzed experimentally the requirements of turning, drilling, and threading operations in terms of such cutting-fluid properties as cooling capacity, friction characteristics, viscosity, and wetting ability. Performance was judged on the basis of tool life, tool forces, uniformity of cutting, and surface finish. Tool life received the major attention and the cause of tool failure—overheating, wear, or welding—was related to cutting-fluid properties.

Many valuable advances in metal cutting are made under the stress of commercial operation and are not reported in formal research papers. Application of the cutting fluid as a mist is a case in point. However, Brosheer (91) has written an informative report on recent developments in this field in the nation's leading metalworking plants and describes its advantages and limitations for a number of cutting operations. Fluids range from kerosene to regular oil-base fluids while water-base fluids, because of their high evaporation rate and excellent cooling properties, hold special advantage for this mode of application.

The advantages of incorporating wax in cutting fluids are reported by Carse and Budner (92) for a variety of operations on SAE 1018, 2-S aluminum, and 304-type stainless steel. Pahlitzsch (93) reports on the status of CO_2 as a cutting fluid after extensive trial under commercial conditions.

In a study of drawing mild-steel wire at temperatures ranging from —40 C to 625 C, Thompson, Carroll, and Bevitt (94) found lubrication to be a controlling factor and gave it considerable attention. The best high-temperature lubricant proved to be graphite, preferably dispersed in "white spirit." The lubricants, such as brown soap, which are outstanding at ambient temperatures, also are effective at temperatures as low as —40 C. The tests were made with tungsten-carbide dies with a half-die angle of 5 deg and at a drawing speed of 3.4 fpm.

Wojtowicz (95) developed a simple test for deep-drawing lubricants which measures the force required to draw a lubricated strip of appropriate metal between two opposing dies, preloaded to 1250 to 5000 psi. The test was used for formulating lubricants for specific applications. The author includes a discussion of the relative merits of different types of lubricants and general rules for formulation of such lubricants.

Boundary Lubrication

Solid Friction. Experiments conducted by Burwell and Rabinowicz (96) on the determination of friction between steel and lead or indium indicate that the friction force is a function of both normal load and sliding speed. The speed influences shear strain rate at the welded junction and the length of time available for development of full strength at the junction of the two surfaces. These results indicate also that the static coefficient of friction depends on the rate of application of tangential force.

Bowers, Clinton, and Zisman (97) report frictional properties of a number of linear high polymers made from halogenated derivatives of ethylene. Data are given for steel sliding on polymer, polymer on steel, and polymer on polymer. The physical form and chemical composition of the polymer is shown to influence its frictional behavior.

King and Tabor (98) have measured yield strength P and shear strength S for polyethylene, Teflon, Kel-F, and Perspex over the temperature range of —100 to 80 C. Coefficients of kinetic friction were also determined over this range for like pairs of these materials. For polyethylene, the coefficient of friction is approximately equal to S/P; for Teflon, S/P is greater than μ, while for the other two plastics μ is greater. Enhanced junction strength of Kel-F and Perspex in the manner of brittle materials accounts for the high coefficients of friction noted. The low junction strength of Teflon is attributed to low intermolecular forces where mechanical interlocking is not possible.

Polytetrafluoroethylene appears to have great possibilities as a low friction antiseizure bearing material, particularly when impregnated into metal surfaces, according to the Production Engineering Research Association of Great Britain (99).

Friction experiments with a number of different rubbers and gelatins are reported by Denny (100). He found that at low loads the area of real contact is almost directly proportional to the load, while at high loads the frictional force approaches constancy. This latter result suggests that the area of real contact ceases to increase at some point. Evidence of the existence of a component similar to the "ploughing" term for rigid materials is presented.

Solid Lubricants. Godfrey and Bisson (101), continuing their study of bonded films of molybdenum disulphide, recommended four general bonding materials, corn syrup, glycerol, silicone-base varnish, and asphalt-base varnish. All methods gave tenacious films of lubricant exhibiting low coefficients of friction at sliding velocities as high as 7000 fpm. Corn-syrup films showed the greatest endurance, followed by the asphalt-base films. Bonded films were found to be generally more durable than cadmium or silver plate in continuous sliding experiments with periodically increasing load. Campbell (111) shows that lubricant-binder ratio and surface quality are important in preparing bonded films.

Davison (102) mentions a number of commercial applications where molybdenum disulphide is effective in reducing friction and wear. Data are included on the load required to force a lubricated pin into an undersized bushing where MoS_2 gives excellent results.

The use of sulphur in porous-metal bearings provides superior lubrication under adverse conditions of heat and pressure according to Maassen (103).

Boundary and EP Lubrication. Kinetic friction experiments on 15 synthetic lubricants and one uncompounded petroleum oil are reported by Johnson, Swikert, and Bisson (104). In these tests a steel ball slid over a steel plate with a velocity of 75 to 18,000 fpm. The load on the ball was sufficient to give an initial Hertz surface stress of 126,000 psi. Velocity for incipient surface failure was appreciably higher for most of the synthetic fluids studied than for the petroleum oils. A blend of $^1/_3$ diester and $^2/_3$ silicone showed no surface failure below 10,000 fpm. With nonreactive specimens, a diester fluid failed to provide lubrication, indicating the need for considering the materials to be lubricated in such a system.

Valuable data on the temperature at which various synthetic fluids fail to lubricate under boundary conditions are presented by Murray, Johnson, and Bisson (105). Synthetics, other than silicones, were found to be more effective than petroleum lubricants, although certain esters gave corrosive decomposition products. Results of these experiments further support the theory that effective lubrication with esters is due to metal soaps formed from free acids in the lubricant.

An interferometric method of measuring the separation of two lubricated plates is described by von Schiessl (106). A cast-iron plate and steel ring with a film of oil between are subjected to a normal force causing separation. The measured values are found to agree well with those predicted by hydrodynamic theory, and the initial film thickness is believed to be due to boundary properties of the lubricant film.

Studies by DeArdo and Kipp (107) on Timken machine tests of EP lubricants indicate that running speed is the principal variable affecting results. Consequently, these authors advocate that Timken tests be run over the entire speed range of the machine.

Fretting. Feng and Rightmire (108) have extended Feng's theory of wear to cover fretting. They propose that fretting begins with ordinary wear, followed by oxidation of the loose wear particles. Since these particles are trapped, they contribute greatly to the wear

by their abrasive action; in the final stages, damage is due almost entirely to abrasion. Large pits are formed by the merging of a number of adjacent small pits.

An ASTM symposium (109) on fretting comprises five papers dealing with this phenomenon. Campbell provides a general discussion of the fretting of metal surfaces. Results of tests to determine fretting tendencies are reported by McDowell; material combinations are rated as possessing poor, average, or good resistance to fretting. Horger points out that fretting influences the fatigue strength of fitted members and indicates how improvements in resistance to fatigue-crack initiation and propagation may be realized. Herbek and Strohecker discuss the effect of greases in reducing fretting in a machine using a ball thrust bearing as the test element; they find that good feedability of the grease is essential in reducing fretting damage. Another type of test machine is described by Uhlig, Tierney, and McClellan; fretting, as measured by weight loss, is found to be proportional to relative slip.

Reviews. Bisson (110) reviews the important NACA experimental work on solid surface films, particularly that pertaining to molybdenum disulphide. A comprehensive discussion by Campbell (111) covers the mechanism of solid friction and the properties, classes, and applications of solid lubricants. West (112) surveys the various theories of friction of unlubricated surfaces and of boundary lubrication; an extensive bibliography is included.

A paper by Barwell (113) reviews the more common wear phenomena, particularly with regard to the part played by surface layers in affecting wear.

Bowden (114) discusses the effect of surface layers on friction. His data illustrate the effect of oxygen and water vapor, organic-acid vapors, and chlorine in reducing friction. The reactivity of the metal surface, temperature effects, and the mechanism of boundary lubrication are included in his treatment of the subject.

Properties of Lubricants

Ruppert (115) has shown the relation of the Kiesskalt rule for pressure coefficient of viscosity to a number of other laws, all having the form $d(\ln y) = kdx$. Kiesskalt's relation states that the pressure increase to double the viscosity of a lubricating oil is independent of pressure or viscosity and depends only on the temperature and nature of the oil. Wittenberger (116) discusses the temperature-viscosity function of organic liquids, emphasizing the relation of viscosity to absolute temperature. Calculations by Kochanowsky (117) of the average lubricant pressure between two inclined planes sliding with respect to each other gave unrealistic results at high loads and at low speeds. This is attributed to the assumption that viscosity is an exponential function of pressure. A square-root relation between viscosity and pressure is proposed which leads to better values.

A report by Charron (118) describes measurements of the viscosity of glycerine and lubricating oil under rapidly varying pressure in the range of 1–1000 atm. Little (119) describes experiments with naphthenic and paraffinic oils in contact with Freon 22 to determine the viscosity of mixtures as a function of the amount of gas absorbed.

Peterson and Bondi (120) isolated the soap skeleton of a grease by displacing the oil with liquefied butylene, then liquefied ethylene. The grease was reconstituted by adding oil back to the soap skeleton. The system was shown to be reversible, except when polar compounds are present in the oil. Matthews (121) reviews the recent work on the structure of greases, pointing out that grease properties can be controlled by controlling the state of aggregation and length:diameter ratios of the soap fibers.

Pinic-acid diesters are described by Murphy, O'Rear, and Zisman (122). Their study includes preparation, properties, and lubricant applications; like other diesters, these compounds have high flash points, low pour points, and high viscosity indices. Zisman (123) reviews the knowledge accumulated on synthetic lubricants over the past 10 years and cites numerous military applications of these products. Crampton, et al. (124) discuss the use of synthetic oils in turboengines.

A progress report published by Ohio State University (125) deals with the analysis and testing of lubricating-oil fractions of crude petroleum. Methods for determining structural composition of such fractions are based on the comparison of properties with those of pure high-molecular-weight hydrocarbons. A unit has been announced (126) which is said to screen lubricants quickly on the basis of oxidation stability, sludge and varnish formation, and corrosion characteristics.

Diamond, Kennedy, and Larsen (127) present a kinetic study of oil oxidation in the range above 220 C extending the knowledge of the oxidation of lubricants to near the ignition point. Using a number of metal catalysts in different forms, an oxygen-absorption system, and oil in thin films, they found catalysis to be mainly homogeneous. All metals tested showed some catalytic effect, copper being most active. Only one type of oil was studied.

Spontaneous-ignition temperatures of a number of hydrocarbon and synthetic lubricants are reported by Frank, Blackham, and Swarts (128). The influence of additives and metal surfaces are included in the study. Baldwin and Daniel (129) describe apparatus for measuring the solubility of gases in lubricating oils and fuels. Results are reported for a number of gases in several solvent-treated lubricating oils and some fuels.

The viscosities of dilute solutions of sodium phenylstearate in benzene are reported by Honig and Singleterry (130). They show that small amounts of certain polar additives, such as water, organic acids, alcohols, or phenols, drastically reduce the viscosity of the solution. The effects produced by water, alcohols, and phenol are reversed by heating to 70 C. The effect of organic acids such as phenylstearic is not reversible.

Miscellaneous

Mathematical symbols for lubrication problems, which have been adopted by the American Society of Lubrication Engineers, are presented and discussed by Boyd (131). These symbols evolved from an earlier proposal which was carefully studied and revised to meet the problems of lubrication engineers.

Books

A report describing the work done, under ASME sponsorship, on the viscosity and density of lubricants under high pressure (132) has been published. Volume I gives the text of the report, details of the equipment

and methods, and physical and chemical data on the samples tested. Volume II contains graphical and tabular viscosity and density data, and information on the pressures causing the formation of solids. Forty-six different materials were tested, including synthetics, pure hydrocarbon compounds in the lubricating range, and representative petroleum oils.

Two German volumes (133, 134) on bearings have appeared. The first is a monograph by Schmid and Weber on sleeve-bearing theory, design, lubrication, testing, and manufacture. Both metallic and nonmetallic bearings are considered. The second is a compendium on bearing materials, dealing with the testing and evaluation of sleeve bearings, metallic and nonmetallic.

A treatise on sleeve-bearing metals by Borge Lunn (135) discusses various lubrication and bearing-metal theories previously proposed and the composition and properties of bearing metals. A hypothesis is stated wherein lubrication under boundary conditions determines bearing performance. This is accomplished through the formation of an adhesive film produced by a chemical reaction among the rubbing metals, the lubricant, and the surrounding atmosphere. An interesting technique has been developed in which the electrical resistance of the lubricant film is followed during the test. Many test results are shown, principally with white metals.

Hersey and Hopkins (136) have co-ordinated the data from 12 investigations of the viscosity of lubricants under pressure. All available data on the lubricants tested are included, and the results of the high-pressure viscosity tests are analyzed extensively. Of the 148 lubricants tested, 25 were fatty oils, 94 were petroleum oils, 17 were compounded oils, and 12 were other materials useful as lubricants. There is no duplication of data with reference (132) mentioned previously.

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Briefing the Record

Abstracts and Comments Based on Current Periodicals and Events

J. J. Jaklitsch, Jr., *Associate Editor*

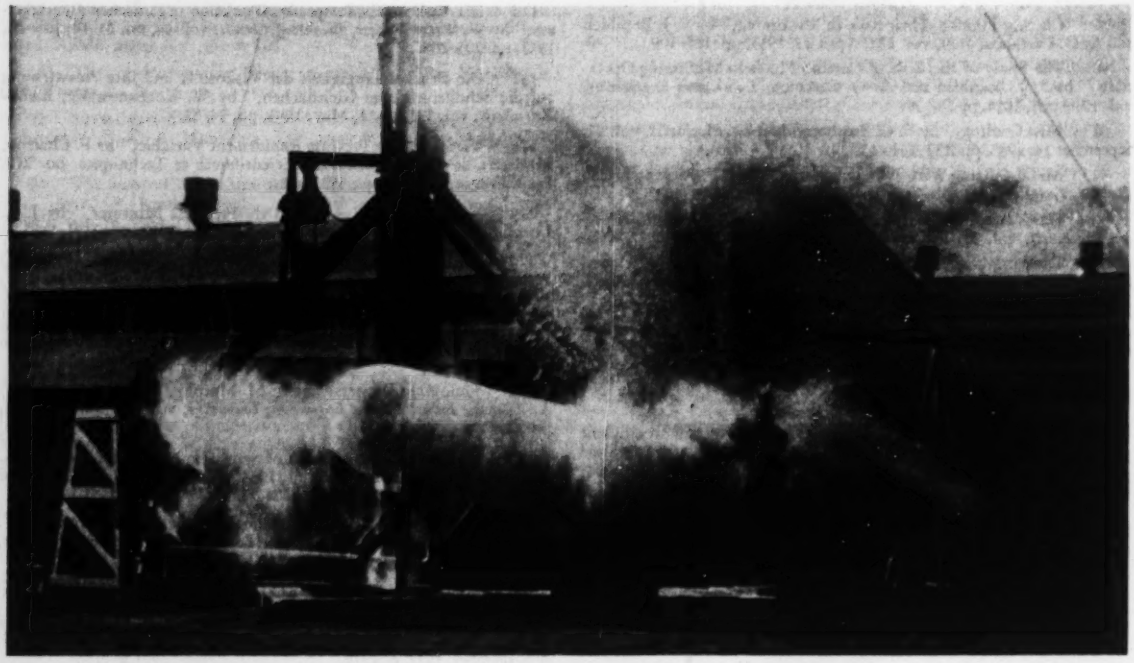


Fig. 1 Geyser of icy calcium-chloride brine rises as big steel tank, frozen at 45 degrees below zero, is burst from internal pressure of 2850 psi. Steel is a new type, known as "Carilloy T-1," developed by United States Steel Corporation. Burst test was one of a series made on Chicago Bridge and Iron Company plant site in Birmingham, Ala., on June 29 and 30.

Pressure-Vessel Tests

COATED with ice at 45 deg below zero, four large closed pressure tanks of a new kind of steel were put through burst and impact-test paces, June 29 and 30, in Birmingham, Ala.

The vessels were made of a new quenched and tempered steel known as "Carilloy T-1," a product of United States Steel Corporation's Research Laboratory.

The tests were staged in an open area adjoining the plant of Chicago Bridge and Iron Company. Engineers and research experts of both companies took part in the series of tests before an audience of government and technical code authorities, representatives of the Atomic Energy Commission, army and navy officers, as well as the heads of military and civilian aeronautical groups.

The following specific regulatory bodies were invited: ASME Boiler Code Committee, U. S. Navy Department, U. S. Coast Guard, American Bureau of Shipping, American Petroleum Institute, U. S. Atomic Energy Commission, U. S. Army, U. S. Air Force, National Advisory Committee for Aeronautics, U. S. Army Engineers, Pressure Vessel Research Committee, American Water Works Association, Interstate Commerce Commission, National Research Council, Bureau of Reclamation, and ASA (Code for Pressure Piping).

"Operation T-1," as the test series were called, ticked off with the precision of a military maneuver, but behind the scenes long hours of hard work were required to bring the steel of the tanks down to the low temperature required. They were cooled by pumping into them hundreds of gallons of calcium-chloride brine chilled by dry ice.

Two separate test methods—burst tests and drop impact tests—were used to demonstrate the strength and toughness of the steel. Two burst tests were made on alternate days to determine how much internal pressure the tanks could withstand before they burst. In the drop tests a new method of testing full-scale vessels was used. A 26,700-lb steel weight was let fall upon the tanks from heights of 52, 73, and 101 ft to show the toughness of the steel at low temperatures. Internal pressure in the drop tests was 1875 psi.

Outwardly, when ready for the tests the four tanks appeared identical—20 ft long, including their hemispherical ends, and 48 in. in diam, made from steel plates

1/2 in. thick, crusted with white frost, but the two tanks tested the first day were not "stress-relieved"; that is, they were in the natural condition, as-welded. Those of the second-day's tests had been stress-relieved or given a special heat-treatment following their fabrication so that internal stresses caused by the fabrication and welding were minimized. The objective was to compare how both kinds of tanks would react to the same tests.

Results of the tests performed on the four tanks were as follows:

1 June 29, burst test nonstress-relieved vessel at —45 F; 2850 psi internal pressure at moment of burst.
2 June 29, drop test nonstress-relieved vessel at —45 F; 26,700-lb weight dropped from 101 ft caused break.
3 June 30, first test on stress-relieved vessel at —45 F; 2850 psi internal pressure at moment of burst.
4 June 30, drop test on stress-relieved vessel at —45 F; 26,700-lb weight dropped from 101 ft caused break.

At intervals throughout the test periods girth measurements of the tanks were made and recorded to show swelling and deformation.

Results of the burst and drop tests were spectacular. The steel showed tremendous toughness even at the very low test temperature. Yellow calcium-chloride brine gushed like a geyser from a hole burst in the tank.

When the drop tests were completed the tanks had amply demonstrated their ability to withstand tremendous shock.

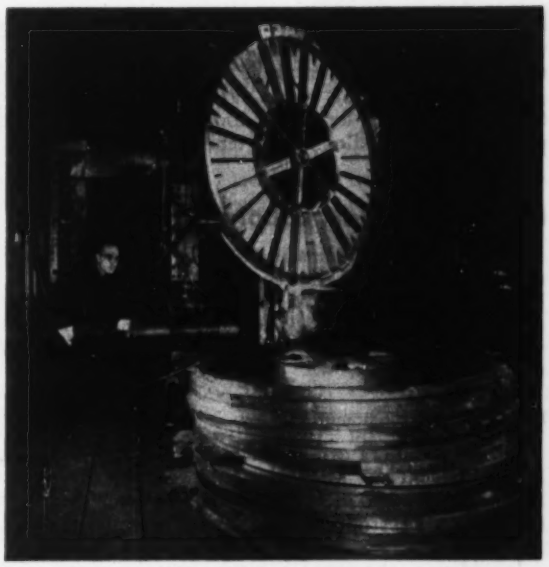


Fig. 3 Workman is shown here removing 41-lb aluminum die-cast flange for cable reel from the 72-in. die-casting machine. After gate and flash are removed casting weighs 31 lb.

72-In. Aluminum Die-Casting Machine

A NEW 72-in. aluminum die-casting machine, said to be the largest ever built, was unveiled recently by the Doehler-Jarvis Division of National Lead Company, Toledo, Ohio. This project represents a joint development between Doehler-Jarvis and Kaiser Aluminum & Chemical Corporation.

Primarily designed for aluminum and with the automotive market specifically in mind, the machine is capable of turning out aluminum die castings weighing up to 75 lb. When adapted to zinc use, castings up to 200 lb are contemplated. By previous die-casting standards, zinc parts up to 45 lb and aluminum of 20 lb were considered practically maximum.

The mechanical unit weighs approximately 250 tons and will handle dies weighing up to 50 tons. (The 72 in. referred to is the distance between the centers of the four large bars which are the essential framework of a die-casting machine.) The largest machines operated by Doehler-Jarvis previously were 48-in. machines, such as the ones now used to turn out large transmission housings, automobile grilles, and other large die castings.

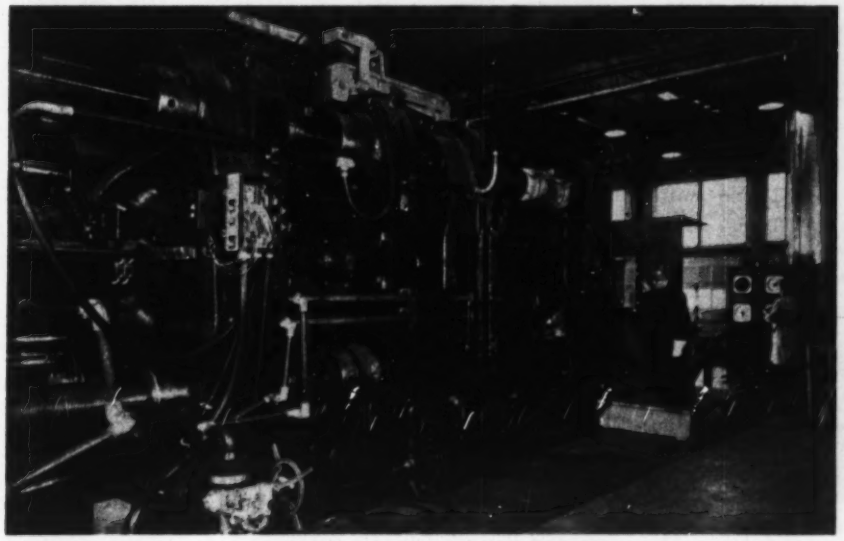


Fig. 2 Side view of 72-in. die-casting machine. Machine weighs 250 tons, will handle dies up to 50 tons in weight, and is capable of producing aluminum die castings up to 75 lb and zinc die castings to 200 lb. It is said to be the largest machine of its type ever built.

It was estimated that on a casting job weighing 75 lb in aluminum the 74-in. machine could operate at a production rate of 30 "shots" per hour and would consume in excess of 2250 lb of metal per hour. To cope with this high rate of metal consumption, the machine has been equipped with two 12,000-lb reverberatories.

An important production feature in this machine is the development of an automatic ladle to handle adequately this large hourly metal consumption. Maintaining temperatures

for successful casting has been accomplished by setting temperature controls on the ladle itself. Other automatic features of the machine include: Cycle control (or manual), controls for metal temperatures for the furnace, recording for water-cooled shot sleeve temperature, and recording for die temperature.

Friction Materials Laboratory

As AN answer to increasing demand for better control and safer stopping of all types of mechanical equipment, Johns-Manville Corporation recently opened a new Friction Materials Laboratory devoted to research and development of asbestos brake linings and other friction materials.

Inertia-Type Dynamometer

The new laboratory, a part of the Johns-Manville Research Center at Manville, N. J., houses the largest and most versatile inertia-type dynamometer ever built for testing the stopping qualities of aircraft, railroad, truck, bus, and industrial-equipment brake materials.

In addition, the new laboratory contains many other machines for testing a wide range of friction materials, particularly automotive brake linings and clutch facings.

The dynamometer is said to be the largest in the world devoted to testing friction materials. It weighs more than 200 tons and rests on a base of more than 250 tons of reinforced concrete.

This unique dynamometer is capable of reproducing a wide range of braking conditions such as the wheel of a giant bomber or commercial airliner landing at 200 mph, or of a train moving as fast as 150 mph, to the low-speed, high-torque application typical of heavy-duty earth-moving machinery.

Electronic controls and instrumentation provide greater control refinements for these wide-range tests than any other dynamometer of its type in use today.

Fig. 5 Experimental brake block is removed from the brake assembly of the dynamometer following an electronically controlled test. The torque stand, at right, is arranged for two-position torque absorption from high and low-speed shafts of the gear unit. Positions for insertion and retraction of brake assemblies, which can be as large as 60 in. in diam, are controlled by means of hydraulic and air systems

Driving Unit

The driving unit is a triple-speed induction motor set and clutch, which allows for a 500-hp variable-speed drive. This unit can be speed-regulated in infinite steps from 0 to 1500 rpm. The clutch is of the eddy-current type, which couples the single and dual-speed motors to the flywheel section. The clutch mechanism can be used as a brake to stop the dynamometer under emergency conditions.

The driving unit is mounted in tandem with the flywheel unit. This latter unit consists of 16 individual and removable disks weighing 27 tons. The disks can be arranged for an inertia loading of 150 slug ft sq to 6750 slug ft sq in increments of 50 slug ft sq. The disks themselves are balanced dynamically. There is provision for periodic dynamic balance through the use of a vibration meter. The specially designed bearings are lubricated by three methods—oil ring, hydrostatic lift, and hydraulic pressure. Electric controls prevent the bearings from becoming overheated.

Fig. 4 Inertia-type dynamometer for testing friction materials for aircraft, industrial equipment, railroad, truck, and bus brake assemblies. The components are arranged in tandem. At the far right are the triple-speed induction motor and clutch mechanisms. Following, in order, are the inertia wheel disks, the gear-reduction unit, and the torque stand to which the brake assembly at the left is attached. Complete, the dynamometer weighs some 200 tons.

Gear-Reduction Unit

Next in the tandem arrangement of the complete dynamometer is the large gear-reduction unit weighing 10 tons which is rated 5800 hp at 300 rpm. This unit incorporates two output shafts to accommodate both high and low-speed brake applications. It is connected with the flywheel shaft by a Thomas flexible coupling and is

free of backlash. One shaft develops a speed from 0 to 300 rpm; the other develops a speed of 0 to 1500 rpm. Each shaft has a torque range from 0 to 100,000 ft-lb. Antifriction bearings are used on this unit.

Brake Testing

Brakes to be tested are mounted on a torque stand which can be positioned to absorb torque from either the high or low-speed shafts of the gear unit. The positioning for the insertion and retraction of the brake assembly is accomplished by means of hydraulic cylinders. The torque stand is capable of mounting a drum as large as 60 in. in diam.

Constant input and constant torque control are maintained by means of hydraulic and air systems. The air pressure range is 0 to 200 psi. The hydraulic range is 0 to 2000 psi. An exhaust system is provided to cool the brake. A service crane for handling the brake and drum assemblies to be tested is mounted overhead.

The dynamometer is capable of producing 100,000 ft-lb of braking torque and 51,000,000 ft-lb of kinetic energy.

Electronic Control Panel

An elaborate electronic control panel selects and governs either drag tests or cycle tests at adjustable speeds. Test information is recorded on four channel oscillographs. The panel contains the unusual feature of an oscilloscope-movie camera combination, so arranged that oscilloscope readings of surface temperature under high speed can be recorded on film.

Other instrumentation on the panel includes a direct-reading speed computer accurate to $^1/_{10}$ revolution with data recorded on the oscillographs (this computer also electronically records revolutions-to-stop); two temperature indicators and two temperature limiters; four thermocouple d-c amplifiers and four strain-gage amplifiers; two cycle-per-phase counters, range 0 to 400 brake applications; two counters for total or repeat cycles in phase A or B, range 0 to 999,999 applications; cycle timers with maximum ranges of 2 to 120 min; timer for recording at one-second intervals on oscillograph charts; series of switches for program selection; potentiometers for preset speed control of 0 to 1500 rpm and preset brake torque control of 0 to 100,000 lb-ft; and instrumentation for surface temperature pickup from an electronic cell. An electronic timer will "warm up" the electronic components prior to tests.

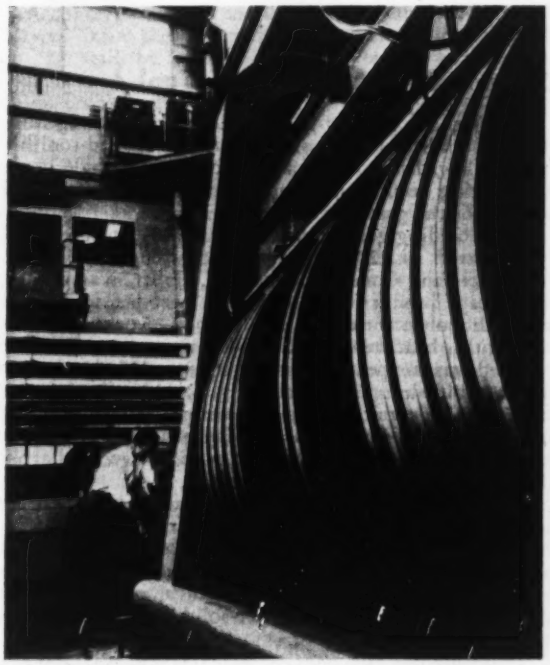


Fig. 6 Huge flywheel disks on the new dynamometer are shown in foreground. The 16 removable disks, weighing 27 tons, can be arranged for an inertia loading of 150 slug ft sq to 6750 slug ft sq in increments of 50 slug ft sq. The flywheel bearings are lubricated by three methods—oil ring, hydrostatic lift, and hydraulic pressure. In addition the bearings are protected from overheating by electrical controls.

Jet-Engine Noise Tests

A HIGH-INTENSITY sound chamber has been developed to test, on a laboratory basis, the effects of jet and rocket-engine noises on electronic components used in aircraft.

Called the "sound box," the chamber was built by scientists at Armour Research Foundation of Illinois Institute of Technology, Chicago, Ill.

Constructed in the shape of a 6-in. cube, the chamber is used in evaluating electron tubes and other components employed in communication, guidance, and armament systems on jet and rocket-driven aircraft and missiles.

The sound box was designed for use in an Air Force research project seeking to determine methods for improving reliability of air-borne electronic components to make them less vulnerable to vibration, acoustics, and shock disturbances.

The project, begun two years ago, is being carried on by Armour under contract with the Wright Air Development Center, near Dayton, Ohio.

Because of the tremendous noise produced in modern jet aircraft, it has become necessary to develop soundproof electronic components in order to prevent malfunctions or complete failure of the equipment, it was pointed out.

The sound box, operating as a reverberant chamber, permits production of high sound levels with only a modest power input. Because of its simplicity, the chamber is an inexpensive and convenient laboratory device.

Noises of 150 decibels—the usual jet-engine noises encountered at some important measuring points— can be produced and utilized in the box.

A decibel is a unit of sound measurement where zero decibel represents the lowest level of human hearing and 100 decibels approximate the noise in a boiler factory.

A sound level of 150 decibels is 100,000 times more intense than boiler-factory noise and is sufficient to cause pain to the human ear.

Tape recordings of actual jet noises could be used with the sound box, but in practice this is not necessary. Instead, sounds fed into the box are supplied by a random noise generator, a device that generates a noise similar to that of jet engines, and by an audio-oscillator, an instrument for electrically generating pure tone sounds.

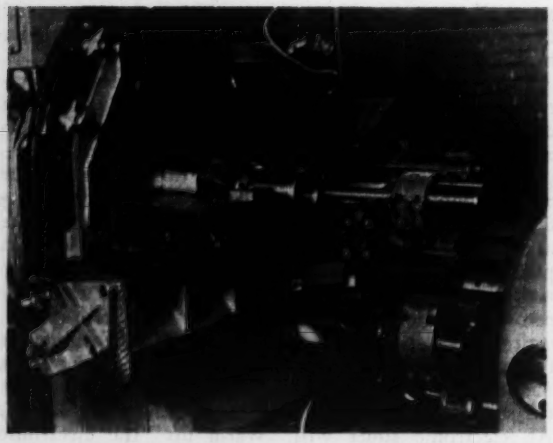


Fig. 7 Closeup of tooling on 12-in. single-spindle automatic chucker for performing 14 machining cuts in first operation setup on master collet blank. After operator loads piece and starts machine, all cuts are performed in automatically controlled cycle until machine stops and workpiece is unloaded.

Fig. 8 Reaming is the final step in this first operation setup of 14 machining cuts for making collet blanks out of SAE-4150 collet steel on the new 12-in. single-spindle automatic chucker. When completed, the collets will be employed in Acme-Gridley single or multiple-spindle automatic bar machines.

Single-Spindle Automatic Chucker

A NEW 12-in. single-spindle automatic chucking machine (Acme-Gridley) has recently been introduced by the National Acme Company, Cleveland, Ohio.

The chucker, it was pointed out, has been proved on job after job up to five times faster floor-to-floor time than former methods for this class of work because of its predetermined cycle time for all machining operations in a setup. There is no time loss from the start of the machining sequence after loading until the finished piece is unloaded. This has resulted in less operator fatigue, the same machine cycle rate at the end of a shift as at the start, faster and more accurately scheduled production. And with its open tooling zone and easily accessible chucking area, there is plenty of room for automatic loading equipment to adapt this machine to an "automation line."

Wider speed and feed ranges with speed changes automatically controlled during the machine cycle give the chucker greater versatility in combining carbide and high-speed tooling as well as threading in the same automatic setup. Each of the five turret toolslides and two cross slides is independently cammed. "Idle time" movements such as advancing toolslides to cutting position, returning them after completion of cut to turret-indexing position, and indexing of the turret slides, are all accelerated. With these features, more machining operations are incorporated into an automatically controlled cycle and the total machining time per piece for all operations in the setup is predetermined exactly in accordance with tolerances and finish required.

The 12-in. Universal Model MC is easy to tool up. The tooling zone is without interference from shafts or accessories—operator has free access to tools at elbow height. Cams for the toolslides are readily accessible, and the timing control switches are grouped for operation from cam dogs mounted on a single drum at the rear of the machine. This design for quick change-over from job to job makes this air-operated chucker economical and practicable for small-lot setups as well as long production runs.

Adaptability for additional tooling, including specialized attachments for self-opening threading dies and collapsible taps, permits more operations to be included in a single automatic setup, thus avoiding rehandling the piece. This means not only parts of greater accuracy, but also saves valuable man-hours and releases equipment for other uses.

Cemented-Carbide Cutting Tool

AN AIRCRAFT landing-gear manufacturer making difficult cuts on heat-treated steel forgings increased tool life by 6 to 1 with the use of a new cemented-carbide grade 350 cutting tool, decreasing machine down time and loading of the grinding room.

On a landing-gear torque strut of 4340 forged steel heat-treated to 220,000 psi tensile strength, Menasco Manufacturing Company, Burbank, Calif., was getting an average production of only one part per tool grind when the job was running at 170 sfpm. Rockwell hardness at this heat-treat is around 46 C.

Speed was stepped up from 170 sfpm to 227 sfpm, when a new carbide designed especially by Carboloy Department of General Electric Company, Detroit, Mich., was put on the job. One-half hour per day machine down time was eliminated and cost of that operation was sharply decreased.

Work was done on a Monarch 25-in. lathe with air tracer attachment. The cut was $3^7/_8$ in. OD and 36 in. long, turning at varying depths of cut through scaly stock. The setup conditions were average with excessive tool overhang required to clear a flange on the part, and only a moderate flow of water-soluble coolant available.

Two roughing cuts varying from 0.060 in. to 0.200 in., and a finish cut of 0.060 in. depth, were taken with Carboloy grade 350. Feed was 0.010 in. per revolution.

A standard Carboloy tool was slightly modified for this application. A positive 3-deg side-cutting edge angle and 15-deg end-cutting edge angle were combined with a zero-degree back rake and positive 6-deg side

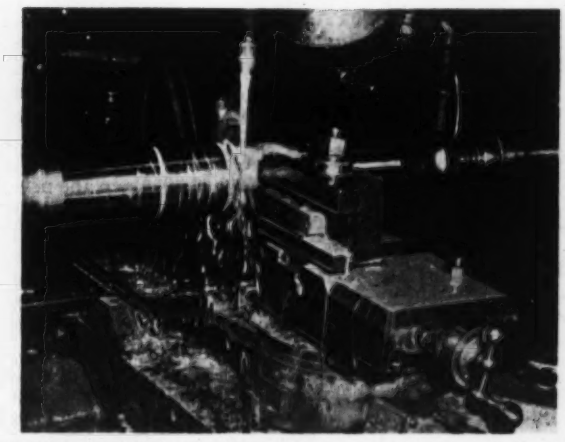


Fig. 9 Machining speed on this 4340 forged steel heat-treated to 220,000 psi was stepped up from 170 to 227 sfpm when carbide grade 350 was applied. Menasco Manufacturing Company, Burbank, Calif., has improved tool life 600 per cent through the use of grade 350 on this particular job.

rake. Relief angles were 6-deg, clearance 10-deg, and a $^1/_{32}$-in. nose radius was used. The chipbreaker was 0.060 in. wide × 0.015 in. deep.

Nuclear Engineers

ACCORDING to a recent issue of "Columbia Research News," it has been estimated that within 10 years nuclear energy will be competing with conventional power sources in this country. Five years from now over 5000 engineers skilled in atomic manipulations will be needed by the new industry.

How to train these nuclear engineers, this newsletter reports, was the problem tackled recently by 36 distinguished scientists and educators from the laboratories of government, industry, and the universities. They met for three days at Columbia University in a "Closed Conference on Nuclear Physics in Engineering Education," sponsored jointly by the American Society for Engineering Education, the American Institute of Physics, the National Science Foundation, Northwestern and Columbia Universities. Prof. Charles F. Bonilla of Columbia's Chemical Engineering Department was chairman.

The major conclusions reached were as follows: (1) The majority of engineers employed in the nuclear field do not require a detailed knowledge of nuclear science, but must have a qualitative knowledge of it; (2) wide specialization in nuclear-engineering problems as another major engineering discipline is not warranted at the undergraduate level; and (3) the most important quality for any engineer in the nuclear field to have is the ability to think analytically and creatively, since technology in this field is diverse and rapidly becomes obsolescent.

While the foregoing suggests that engineers need not specialize in nuclear engineering but should have a qualitative knowledge of it, it seems evident that every mechanical-engineering curriculum should be so designed that the student will be able to keep abreast of future developments in nuclear-energy applications and be able to work effectively in that field should the necessity for him to do so arise during his engineering career.

Take the mechanical engineer, for example. The atom is well on the way to being harnessed as a useful peacetime power producer. In fact, at a recent meeting of the Atomic Industrial Forum, it was predicted that atomic power plants would be generating electricity within 5 to 10 years. And, to start the ball rolling, work is already commencing on the first central-station atomic-power plant—a 60,000-kw pressurized-water reactor. Apart from the reactor portion, the plant will employ conventional central-station steam, electric, and other auxiliary systems. These latter, of course, will be "old hat" to the mechanical, but he should have some basic knowledge in nuclear engineering in order successfully to combine the conventional parts with the nuclear portion of a plant. The mechanical may not be called on to design a nuclear power reactor as such but it is obvious that if we are commencing construction of these power plants he should be well-grounded in the fundamentals of nuclear science and nuclear engineering.

There are not only the power-plant phases to consider when discussing the atom but also the many peacetime uses of isotopes which day by day are becoming of greater industrial importance.

In other words, many mechanical engineers, both as graduates and undergraduates, will become involved, sooner or later, with nuclear problems. It is obvious, therefore, that our engineering schools should plan to include in their engineering curriculums some basic instruction in nuclear science designed specifically for the engineer.

As University of Michigan President Harlan Hatcher put it recently, "Education faces a task that will stretch its capacity to the utmost in turning the destructive power of the atom into useful ways." He spoke before the International Congress on Nuclear Engineering sponsored by the Nuclear Engineering Division of the American Institute of Chemical Engineers at Ann Arbor, Mich.

"Specifically," President Hatcher said, "it is the obligation of education to move with all energy and speed to dissipate the dark clouds of gloom and terror that surround nuclear fission as a physical fact, to train and direct men in the vision and the skill to move its power over into peaceful and beneficent applications, and to adjust our social and governmental agencies to absorb the new dimensions of life imposed by this new force conjoined with its caravan of aircraft, radar, and attendant electronic devices."

Atomic-Power Reactors

Sodium-Graphite Nuclear Reactor

A NEW reactor will be designed, built, and operated by North American Aviation, Inc., of Downey, Calif, as part of the Atomic Energy Commisssion's program to develop competitive nuclear power, the company announced recently.

This new reactor work will be jointly financed by North American and the Atomic Energy Commission at a cost of about $10 million, including research and development. North American will assume $2.5 million of this cost. The company also will provide land for the reactor site.

Called the SRE (Sodium Reactor Experiment), it will be a "sodium-graphite" nuclear reactor generating 20,000 kw of energy in the form of heat. This type of reactor will operate at higher temperatures than do some other

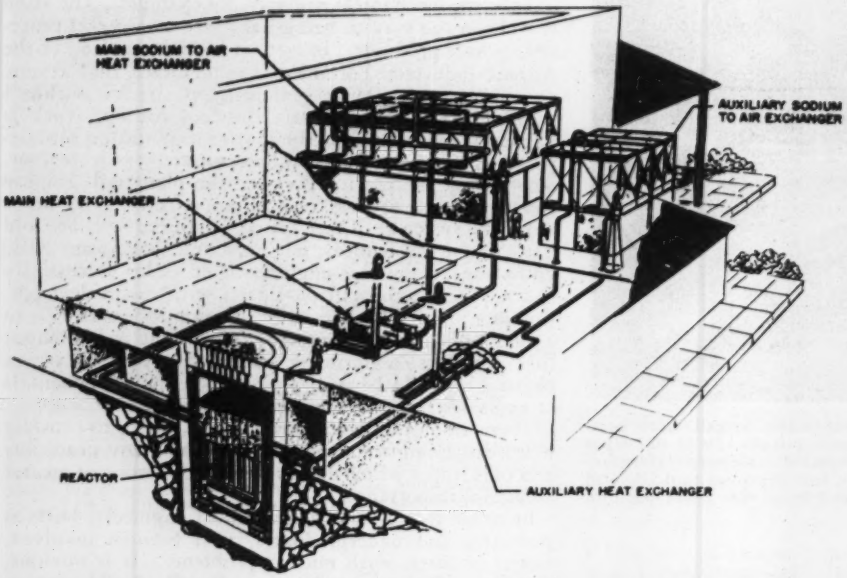


Fig. 10 Artist's conception of new sodium-graphite nuclear reactor to be designed, built, and operated by North American Aviation, Inc., in a joint project with the Atomic Energy Commission. It will be used for special studies in development work toward eventual production of electricity from atomic energy at costs competitive with cost of power from coal and oil. Heat will be produced by the reactor (*front*) and absorbed by liquid sodium. The hot sodium will be pumped out of the reactor to the main heat exchanger (*center*) where another sodium system absorbs the heat in order to carry it to exhaust fans (*upper right*).

reactor types. This is expected to result in high over-all plant efficiency.

Because the most essential development problems are in the reactor and heat-exchanger system rather than in turbines and other generating equipment, no electricity will be produced at this time. When fission occurs in the reactor, heat will be produced. This heat will be transferred to liquid sodium circulating through the "core" of the reactor where the fission takes place. The sodium will then be pumped to an exchanger where the heat will be removed. If electricity were to be produced, the heat would be used to make steam, which in turn would drive a turbogenerator.

Actually, work with the SRE is expected to provide some of the detailed engineering experience and to develop some of the operational equipment needed to produce economical power.

The development of fuel elements and various combinations of fissionable materials for the reactor core will be an important part of the program. The reactor is slated to use uranium slightly enriched in uranium 235 in the core. Studies can also be made with thorium, and uranium 233, in the core.

Studies will be made of various materials, components, and structural assemblies to check their function in the nuclear-reactor system.

Characteristics of sodium which make it particularly suitable as a reactor coolant are the metal's low neutron-absorption qualities, good heat-transfer properties, low melting point, and high boiling point. Use of sodium permits the production of the high temperature without high pressure.

The reactor, including the core and the cooling sodium, will be encased in a steel tank. This entire unit is to be installed underground, with five feet of dense concrete between the reactor and ground level.

Graphite, used to moderate or slow down the neutrons which cause the uranium 235 to fission, will surround the fuel. The design calls for 10,000 gal of sodium to flow through the core and absorb the heat of the fission process.

Boron-steel control rods will regulate the fission rate of the reactor and are to be moved by electric motors in and out of the core. Such rods control the fission process by absorbing neutrons. Safety elements will serve to stop fission and shut down the reactor when required.

The sodium will be heated and pumped to a primary heat exchanger. Because the sodium coming directly from the reactor will be radioactive, this metal will give up its heat through a primary exchanger to another sodium circulation system. The second system will take the heat via uncontaminated sodium to a second exchanger where the heat can be provided without the presence of radioactivity.

No fumes, gases, or other exhaust material will be emitted into the atmosphere, as the reactor will operate on a closed-cycle system.

Only three technicians will be required to operate the reactor. Other engineers and scientists at the site will conduct various investigations and studies for the industrial-power development program. The reactor is expected to be completed in about two years.

Atomic Research Reactors

Two relatively low-cost atomic research reactors adapted for use in training badly needed personnel for the nuclear-power industry, as well as for conducting basic nuclear research and development, have been placed on the market by the Atomic Energy Division of The Babcock & Wilcox Company, New York, N. Y. B&W's designs are modified versions of the declassified "water-boiler" and "swimming-pool" reactors developed at Los Alamos, Oak Ridge, and other installations of the Atomic Energy Commission. They will sell for a firm price, depending upon specifications and installation problems, somewhere in the range of $100,000 to $150-000.

Water-Boiler Research Reactor

The B&W water-boiler reactor is a semihomogeneous unit comprising a solution of enriched uranium sulphate

in water as fuel and moderator, and a separate cooling system of unique design. Its rated power is from 200 to 400 kw but it can be operated at any power below this level.

The uranium-sulphate solution is contained in the lower half of a cylindrical vessel with spherical bottom. The vessel is 10 in. ID × 3 ft high. The shell is $^1/_{16}$ in. thick and is made of Type 347 stainless steel. Boron control and safety rods extend down into the core (solution) from above. The core is located in the center of an approximately 4-ft cube of graphite reflector which, in turn, is surrounded by a 4-in. carbon-steel thermal shield. A 5-ft extension of the graphite reflector on one side serves as a thermal column.

The pressure above the fuel solution is maintained at negative 6 in. of water as a safety feature in order that any leakage will be into the reactor gas system rather than out into the reactor room. Hydrogen and oxygen gases created by fission-induced dissociation of the water in the fuel solution are diluted with helium to keep the concentration well below the danger point and are then recombined in a catalyst bed and returned through a closed loop to the core.

The cooling system comprises U-shaped Type 347 stainless-steel cooling tubes placed so that they dip down into all parts of the fuel solution and maintain the fuel temperature at a constant level below the boiling point. The coolant is ordinary water.

The reactor and its components are contained in an octagonal, high-density concrete shield. Aluminum exposure ports extend to the core or reflector from all shield faces, and two ports are located in the thermal column. The air space within the shield is maintained at a slightly negative pressure as a secondary safety feature.

The over-all design of the water-boiler reactor is similar to that of the Los Alamos water boiler. Introduction of more cooling capacity, however, permits operation at higher power and production of a higher thermal flux than can be achieved with an ordinary water boiler. The total flux density of the unit is in the order of 10^{13} $n/cm^2/sec$. The unit has been designed for high specific power and high thermal flux. The total power and therefore the critical mass is, nevertheless, relatively low compared to other types of reactors.

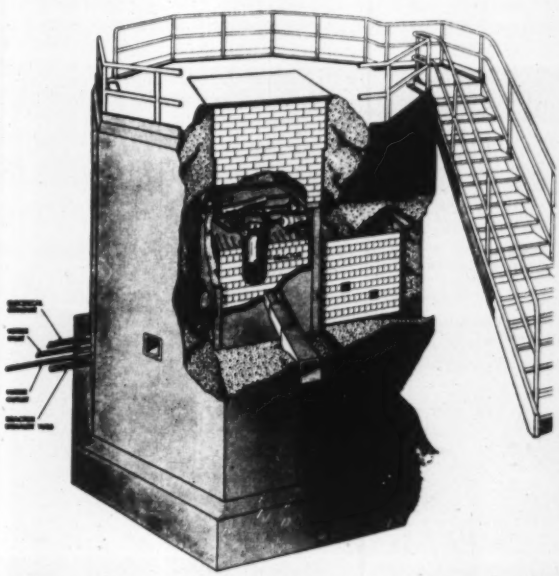


Fig. 11 Babcock & Wilcox water-boiler research reactor. The reactor core is located in the center of a 4-ft cube of graphite reflector which, in turn, is surrounded by a 4-in. carbon-steel shield. Its rated power is 200 to 450 kw.

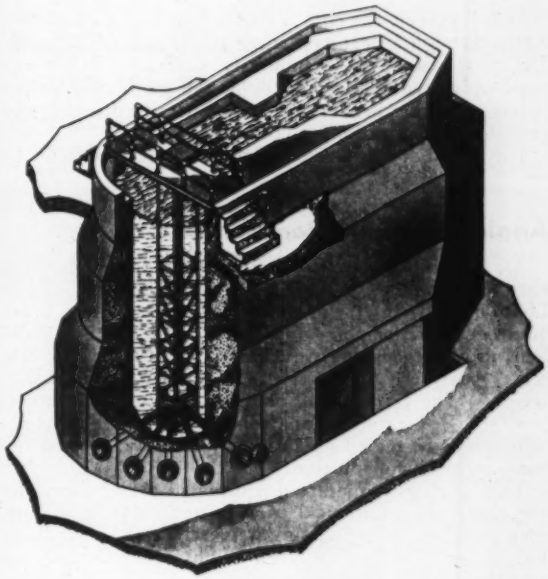


Fig. 12 Babcock & Wilcox swimming-pool research reactor. This reactor's maximum power is about 1000 kw. The core is heterogeneous, with a minimum critical mass of 2.75 kg. The pool is about 10 ft wide × 20 ft long × 25 ft deep.

The water-boiler reactor makes available strong collimated beams of both thermal and mixed neutrons for neutron velocity selectors and other experimental use. Large through-hole facilities with fairly high fluxes can be provided for engineering physics and irradiation experiments.

Swimming-Pool Research Reactor

High degree of flexibility is the outstanding characteristic of the B&W swimming-pool reactor. A modified version of the Oak Ridge bulk-shielding facility reactor, this reactor's maximum power is about 100 kw. The core is heterogeneous, with a minimum critical mass of 2.75 kg. The pool is approximately 10 ft wide × 20 ft long × 25 ft deep and is ordinarily equipped with eight 6-in. and two 8-in. beam ports.

The unit can be operated with a variety of core patterns with or without a partial or full reflector of graphite or BeO. Control is accomplished by rods integrated with the core suspension and actuated by a simplified drive mechanism. Instrumentation also has been simplified.

In addition to its standard beam ports, the swimming-pool reactor usually incorporates three pneumatic tubes for fast "rabbit" experiments. Provision is made for inclusion of special ports and experimental tubes in a number of different arrangements.

At full power, the core is cooled by recirculating pool water through a heat exchanger at the rate of 100 gpm. The pool water is continuously deionized to prevent build-up of radioactivity and, in the event of a power failure, the inlet header will automatically disengage to permit natural convection cooling.

The shield is constructed of high-density concrete.

Analog-Computation Center

AN ANALOG-COMPUTATION center was opened recently near Princeton, N. J., by Electronic Associates, Inc., of Long Branch, N. J., to meet the demand for a headquarters where members of industry can solve their problems in Management Operations Control, Dynamic Systems Analysis, Applications Engineering, and Simulation. The center will provide a staff of scientists available for problem analysis as well as equipment which may be rented on an hourly, weekly, or monthly basis for problem solution.

This analog-computation equipment may be used for the rapid and economical analysis and solution of complex problems in engineering, research design, and distribution; and for the simulation of physical laws and continually varying complex quantities.

The Center, it was pointed out, should prove particularly beneficial to the smaller companies which have not yet found it feasible to invest in their own computation facilities. One of the purposes of this Center is to educate business and industry on the capability of analog computers to economically solve many of their problems with an enormous saving of time.

To each problem, the Center will assign the necessary scientists, engineers, or mathematicians experienced in the use and applications of analog computers to evaluate, set up, and solve problems submitted. When individual situations require specialized aid, the staff will be augmented by experts from various research institutions and universities in the area and from Electronic Associates. These specialists follow the problem from the initial stages of preparation and analysis, through the processing of the problem in the analog computer and the final analysis of the results of the computation. They then prepare a comprehensive report with specific recommendations for the client.

In analyzing and studying a system of management operation, the Computation Center begins with a physical statement of the problem, which may or may not include complete details, depending upon the state of the equipment developed, or on the management operation being analyzed.

The Center then directs its efforts toward formulating a statement of the problem sufficient for analysis and study. After the Center has developed an adequate background of information about the problem, the Center continues its analysis and evolves mathematical equations describing the problem. Then electrical equivalents are assigned to the quantities in the equations. The problem is then prepared for insertion into the computers by making the proper interconnections on a removable patch-panel by means of patch-cords. The Computation Center now feeds the problem into the Analog Computer and receives the results on the output-data-recording equipment.

The Center next evaluates and determines the significance of the results obtained and finally issues a computation report of its observations and recommendations.

The equipment at the Computation Center includes a dual-control console, 96 operational amplifiers, 15 servo multipliers, 4 servo resolvers, 5 servo-type function generators, a two-channel X-Y recorder, and a 6-channel curvilinear recorder. The computer incorporates in its construction more than 900 electronic tubes and over $8\frac{1}{2}$ miles of wire. A quantity of prepatch panels makes it possible to program problems in advance of the time they are actually placed in the computer. This equipment is designed so that it may be expanded when necessary.

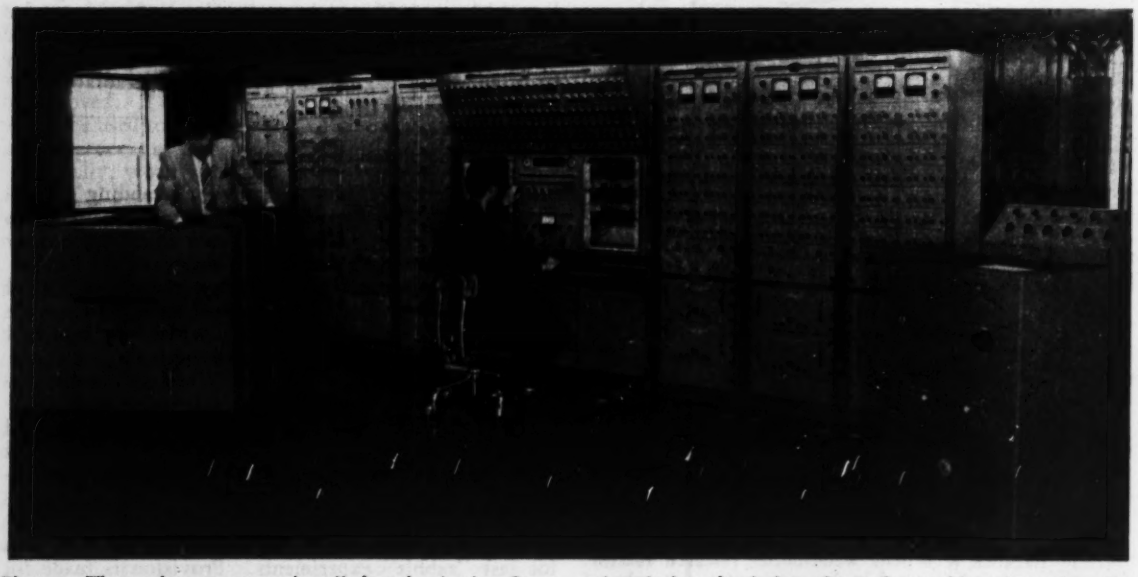


Fig. 13 The analog computer installed at the Analog-Computation Center near Princeton, N. J. This equipment was made by Electronic Associates, Inc., for the rapid and economical analysis and solution of complex problems in engineering research, design, and distribution; and for the simulation of physical laws and continually varying complex quantities.

The dual-control console and related equipment permit the simultaneous solution of two problems or the use of the entire facility to solve more complicated problems.

Electronic analog computers are rapidly taking their place as important tools of industry. This type of computer, as the name "analog" implies, is designed to provide a highly flexible and efficient analogy of an extremely wide variety of physical systems. These physical systems may range from automatic processing plants or high-speed production machines to particular economic systems.

With an electronic analog computer it is now possible to design and analyze the operation of complex equipment before this equipment is layed out on drawing boards or constructed. The analysis (which is very similar to making measurements on the finished products) is performed in the computing laboratory at a speed completely under the control of the operator. Natural processes or systems which operate extremely fast or slow may be slowed down or speeded up on the computer to make the analysis proceed most efficiently. The extremely costly cut and try process can be eliminated and optimum equipment design arrived at before construction begins.

Problems in the field of statistics are a particularly good example where analog computers are extending the frontiers of technique of solutions.

How to Obtain Further Information on "Briefing the Record" Items

Material for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context, and credit to original sources is given.

This material is abstracted from: (1) technical magazines; (2) news stories and releases of manufacturers, Government agencies, and other institutions; and (3) ASME technical papers not preprinted for meetings. Abstracts of ASME preprints will be found in the "ASME Technical Digest" section.

For the texts from which the abstracts of the "Briefing the Record" section are prepared, the reader is referred to the original sources; i.e. (1) The technical magazine mentioned in the abstract, which is on file in the Engineering Societies Library, 29 West 39th St., New York 18, N. Y., and other libraries. (2) The manufacturer, Government agency, or other institution referred to in the abstract. (3) The Engineering Societies Library for ASME papers not preprinted for meetings. Only the original manuscripts of these papers are available. Photostat copies may be purchased from the Library at usual rates, 40 cents per page.

Extruded Automotive Pistons

EXTRUDED aluminum-alloy automotive pistons have successfully met requirements on their first two dynamometer tests following completion of initial trials by one of the major auto builders.

Made by Light Metals Division, Thompson Products, Inc., Cleveland, Ohio, these first extruded automotive pistons for commercial application are also being produced for other automobile manufacturers.

In an initial 120-hr break-in and dynamometer endurance run, and a hot scuff trial in which the pistons, installed in a "green" engine, were run up to 4400 rpm and held there for two hours, results were said to be excellent.

Made of aluminum alloy fashioned by extrusion instead of casting, the new piston is claimed to be up to 50 per cent stronger and up to 30 per cent lighter than the old-style pistons. Made by an impact-extrusion method, this new product is heat-treated for a 100 to 200 per cent increase in tensile strength, greater ductility, and more than 400 per cent increase in fatigue life.

Thompson predicts that one man using the new process would be able to turn out 500 pistons per hour, compared with 100 to 200 per hour by the present casting method.

In its production of pistons, Light Metals handles some 1100 different types, sizes, and models, ranging from diameters of 2.2 in. to 6 in.

Of the 40 to 50 million aluminum pistons made yearly in this country nearly all are cast by the permanent-mold method. This involves making a suitable iron mold into which molten metal can be poured and allowed to solidify into the form of a piston. Such castings require trimming of gates and risers, heat-treatment, and finish machining into parts ready for assembly in an engine.

In Thompson's impact-extrusion method suitable dies are assembled in a press and by feeding in slugs of aluminum the operation produces piston extrusions rapidly. These require trimming of flash, heat-treat, and finish machining.

The extruding process is said to provide closer tolerances, better physical properties and structure, and lends itself very well to an automatic operation that would increase greatly the production per man-hour.

The individual operations are as follows:

1 Cut slugs of proper size from bar stock using either a saw or an abrasive wheel.

2 Heat up slugs in a rotary hearth furnace or in induction equipment.

3 Preheat the extrusion die in the press using a gas torch.

4 Transfer hot slugs to die and extrude in a crank-type hydraulic press. Lubricate between extrusions with graphite grease compound.

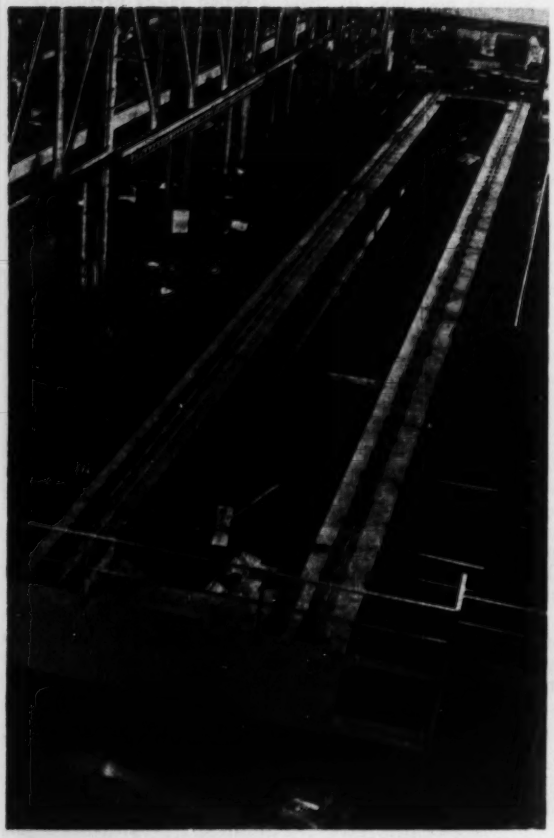
5 Remove flash with a trim die.

6 Heat-treat in gas-fired or electric circulating-air furnaces to develop desired physical properties.

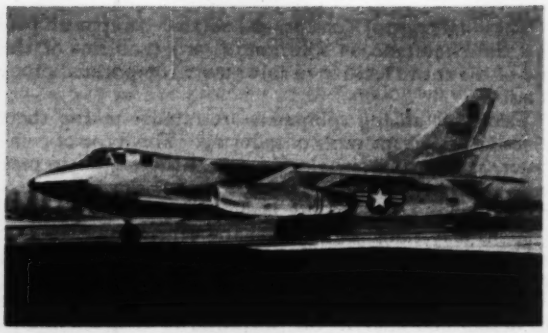
7 Finish machine in usual fashion.

Current automotive-engine design is calling for higher performance by increasing speed and decreasing weight. This means that the piston must be lighter yet stronger. The extruded piston, according to Thompson, fills this need because it can be designed with thinner walls to reduce weight and still have strength to perform the job. One design was almost two ounces lighter when changed from permanent-mold casting, yet it showed no fatigue failure in 40 million test cycles under the same conditions which produced failure in 10 million cycles in the cast piston, the company reported. These improvements result from design changes and better metal structure. All the other features of aluminum pistons—low thermal expansion, high heat conductivity, and ease of machining—are retained.

Engineering developments . . . at a glance

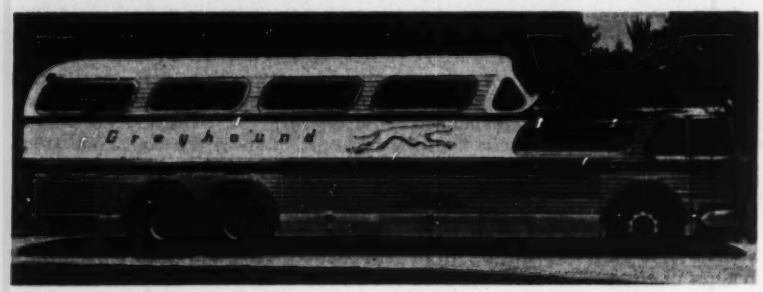


Giant Steel Crane. View of bridge of giant steel crane during construction at The Cleveland Crane & Engineering Company, Wickliffe, Ohio. The bridge girders have an over-all length of 141 ft and weigh 33 tons each. They are of all-welded steel construction. The huge crane itself has a capacity of 10 tons and is of the double-leg gantry type. It will be equipped with a magnet and will be used for handling pig iron in a large steel mill. The crane, which was recently completed and shipped, is said to be the longest ever built by the company.



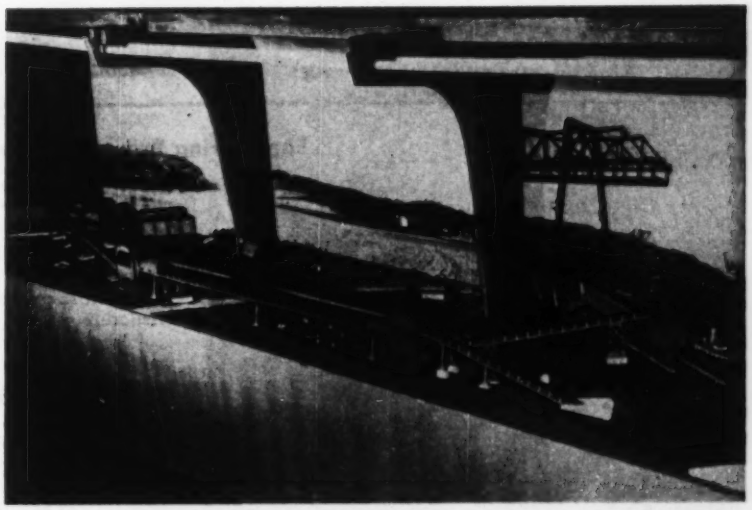
Reconnaissance Bomber. This is the Air Force's new swept-wing bomber, the twin-jet RB66A, which successfully completed its first test hop recently. The plane was built especially for reconnaissance flights by the Douglas Aircraft Company.

Steel-Cutting Machine. Shown in action is a high-speed structural steel-cutting machine that is four times as fast as the conventional saw machine generally used for cutting steel at fabricating plants. It cuts wide steel beams in less than two minutes, compared with about eight minutes for mechanical saws. Developed by the Luria Engineering Company of New York, N. Y., and Bethlehem, Pa., the machine attains its speed by means of three acetylene-oxygen torches that cut heavy structural steel on all sides simultaneously to any bevel within $1/32$ in. Substantial savings in labor costs are a result.



Double-Decker Bus. Ready to roll on the nation's highways is the new Scenicruiser bus which gives passengers unparalleled vision from an elevated rear deck above the level of passing traffic. Developed by General Motors Corporation, the new-type bus has big picture windows of glare-resistant glass which measure six feet in length. In the interior three steps lead from a 10-passenger forward deck to a 33-passenger rear level. Upper level is covered by safety glass.

Proposed Conveyer System. Pictured here is a working model of the proposed Riverlake Belt Conveyer Lines which will connect Lake Erie with the Ohio River via Youngstown to transport coal and iron ore. Built by Goodyear Tire and Rubber Company, the model has 6776 moving parts. End panels show modern river and lake-terminal loading and unloading operations. Central panel shows elevated two-way belts hauling cargoes cross-country along the 100-mile route. Coal is conveyed from barges on the river onto the main-line belt and into storage bins at the lake terminus. Ore is moved in the opposite direction from lake-front stockpiles. Savings of millions of dollars a year on iron ore and coal transportation are expected when the proposed conveyer system is built and put in use.



Integrated Nylon Plant. A bobbin of nylon produced at the Chemstrand Corporation's new Pensacola, Fla., facilities is examined by Henry H. Bitler, president of the Corporation (*left*), and Roy G. Hemminghaus, vice-president and manager of the plant. This new 50 million-lb-per-year plant is said to be the first wholly integrated nylon manufacturing facility in the United States. All the steps in the manufacture of nylon from raw materials to the finished product will take place at this plant. The project comprises a chemical area where the intermediates are produced and a textile area where the fiber is spun. Sixty-two separate structures together with storage tanks, roads, and barge unloading docks are included in the facilities.

Molding Plastic Boxes. Boxes molded from $^{1}/_{20}$-in-thick rigid Geon vinyl plastic by conventional metalworking machinery are shown here. This new approach to the rapid forming of rigid vinyl-plastic products was demonstrated recently by the B. F. Goodrich Chemical Company at the Sixth National Plastics Exhibition. Previously, special expensive injection-molding machines and slow hand-operated draw-forming or blow-forming presses were needed. With the new method a fast conveyer-belt process takes plastic sheet from a preheat oven through to the conventional metal-stamping press which forms the finished shape. No additional finishing operations, such as painting, are necessary to complete the end product.

European Survey

Engineering Progress in the British Isles and Western Europe

J. Foster Petree,[1] Mem. ASME, *European Correspondent*

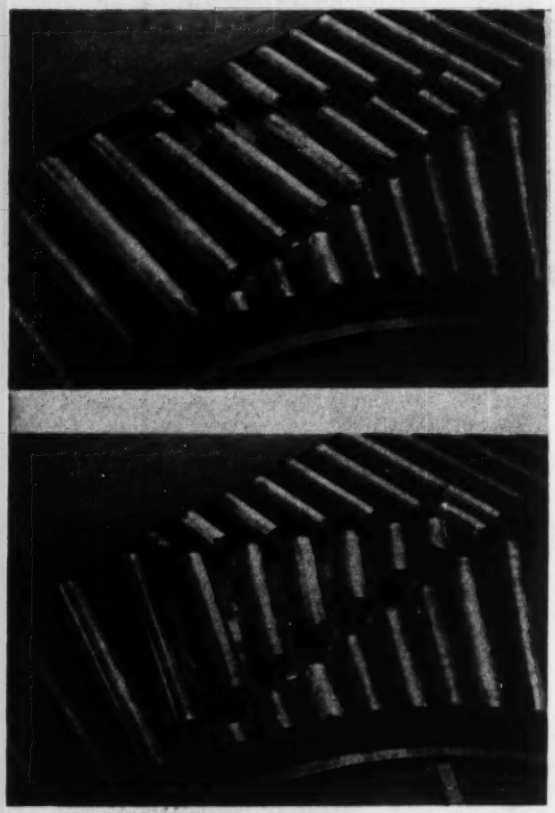


Fig. 1 Roller-conveyer switch as applied to gravity-conveyer system shows switching rollers set for through operation (*top*) and also for switching to a branch conveyer (*bottom*)

Roller-Conveyer Switch

It is a commonplace in mechanical engineering that some of the most effective devices are the simplest in design. Typical of this general principle is a switch for roller conveyers which has been developed by Fisher and Ludlow, Ltd., Bordesley Works, Birmingham, England, in which the switching action is effected by swiveling the rollers at the point of junction. The method is sufficiently clear from Fig. 1 which shows the switching rollers set for through running and for switching to a branch conveyer. Another feature of this conveyer system, which was shown at the British Industries Fair at Birmingham, is a balanced hinged gate which can be swung easily into the vertical position to allow a passage, and which is held in position by a spring-toggle device so compact that it requires a depth only 5 in. more than that of the conveyer itself; thus the conveyer can be set close to the floor, with the minimum of supporting structure.

[1] Correspondence with Mr. Petree should be addressed to 36 Mayfield Road, Sutton, Surrey, England.

Air-Cooled $3^1/_2$-Hp Diesel Engine

Within the past few months the oil-engine firm of R. A. Lister and Company, Dursley, Gloucestershire, England, have put into regular production an entirely new type of single-cylinder air-cooled diesel engine, Fig. 2, intended primarily for agricultural purposes but suitable also for many industrial applications such as driving pumps, saws, air compressors, or generating sets—indeed, for any purpose within its power capacity, which is $3^1/_2$ hp at 1800 rpm, or $1^3/_4$ hp at 900 rpm. It weighs only 250 lb and has been designed to operate with equal reliability under tropical or arctic conditions. On test, the engine has been run at full load for 2000 hr nonstop in an ambient temperature of 132 F.

The single cylinder is 3 in. bore and $3^1/_2$ in. stroke, giving a piston speed of 1050 fpm at the maximum rated output. The bmep is 64 psi at 1500 rpm, and the fuel consumption is 0.55 lb per bhp-hr at full load. The oil consumption for lubrication is stated to be $1^1/_2$ per cent of the fuel consumption. The crankcase, cylinder head, and liner are of close-grained cast iron, but aluminum

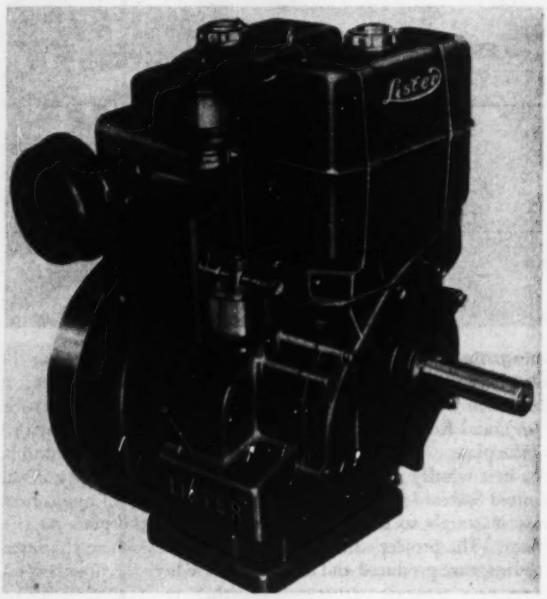


Fig. 2 Lister $3^1/_2$-hp 1-cyl AD air-cooled diesel engine

alloy is used for the cylinder jacket, the fuel-pump casing, the valve-gear cover, and the cooling fan, which is 12 in. in diam. The piston, also of aluminum alloy, has two oil-retaining rings, one above and one below the gudgeon pin, and three compression rings. The combustion chamber is formed as a recess in the piston crown, into which the fuel is injected through a pintle-type nozzle. A separate oil injector is fitted to facilitate starting under conditions of extreme cold; on test, the engine was found to start without difficulty in a temperature of minus 19 F, or 51 deg of frost. For hand-starting, which is the normal method, a decompressor is provided. An electric starter can be added if desired. The fuel flows by gravity from an overhead tank, holding $1^1/_4$ gal, to a fuel filter and thence to the injection pump which is cam-operated. A plunger pump, driven from an eccentric on the camshaft, provides a forced circulation of lubricating oil to the crankshaft and the valve rockers. The crankshaft journals are $2^1/_4$ in. in diam. Shell-type main and big-end bearings are fitted. The engine has an integral reduction gear with a ratio of 2:1, so that either half or full engine speed is available at the output shaft. The governor is contained in the reduction gearwheel and will maintain the speed steady within 3 per cent when running at not less than 1500 rpm. The cooling fan delivers air to the cylinder barrel and head at a uniform rate of 85 cfm per hp at all engine speeds. "Unified" threads are used wherever practicable on bolted connections. The over-all dimensions of the engine are $25^5/_8$ in. long over the crankshaft and gearshaft extensions, $19^1/_{16}$ in. wide, and $24^1/_2$ in. high from the base to the top of the fuel filling cap.

Feed Mechanism for Presses

An automatic mechanism, Figs. 3 and 4, for feeding strip stock into a power press, made by the Birmingham Tool and Gauge Company, Soho Hill, Handsworth, Birmingham, England, was shown at the recent Gauge and Tool Makers' Exhibition in London. It is simple in design and self-contained and can be fitted to almost any type of press. The operating unit consists of a casing containing a slotted crank disk which is rotated by the press drive. The crankpin is mounted on a block which slides in the slot of the disk to give an infinitely variable throw and engages with a slide which is cast integral

Fig. 3 Slide and grippers of Swift-Feeder shown in Fig 4

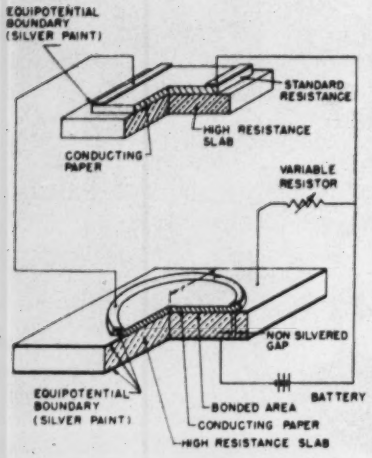
Fig. 4 Swift-Feeder, a feed mechanism for presses, showing slide unit mounted on bar attached to stock reel

with two rams, one on each side of it. By this means, sometimes known as the "Scotch yoke," the rotary motion of the crank imparts a reciprocating movement to the rams. One ram operates the feed mechanism and the other acts as a guide.

The driving ram is a hydraulic fit in a cylinder to which is attached a tube, soft enough to be bent easily by hand to suit the mounting conditions, and coupled at its other end to the feeding slide, in which is a driven ram connected to a wedge form of gripper. The tube is kept filled with oil from a reservoir which is automatically charged by the rotation of the crank disk; thus a slight pressure is maintained in the tube when the press is standing and an accurate feed is assured immediately the press is started. A stationary gripper prevents the feed stock from moving backward, and a reciprocating gripper feeds it forward, the grip being effected by means of a standard $^5/_8$ in. bearing roller working between an inclined upper surface and the stock, which is supported by a horizontal anvil. The driven ram is operated by the oil pressure imparted by the driving ram at the upper end of the tube, but the two rams are also linked by a flexible "core" within the tube; thus, while the forward working stroke is performed by the preloaded column of oil in the tube, the light return stroke, which releases and retracts the gripper, is effected by the flexible member within the tube. The slide of the feeder is open-sided, so that stock can be readily inserted, set in position, or withdrawn. The device, which is known as the "Swift-Feeder," will take stock up to $^1/_8$ in. thick and will make up to 500 strokes per min with a feed accuracy of 0.002 in. The slide unit is carried on an outrigger bar attached to the stock reel, which does not need to be secured to the press, as there is no unbalanced force tending to move it out of position.

ASME Technical Digest

Substance in Brief of Papers Presented at ASME Meetings



The proposed electrical, geometrical analog for the solution of complex heat-conduction problems consists of a resistive plotting surface, a coupled resistor, a direct-current source, and a null-type voltage-measuring device

Heat Transfer

An Electrical Geometrical Analog for Two-Directional Steady-State Heat Conduction With Uniform Internal Heat Generation, by W. R. Simmons, Assoc. Mem. ASME, Argonne National Laboratory, Lemont, Ill. 1954 ASME Semi-Annual Meeting paper No. 54—SA-49 (mimeographed; available to April 1, 1955).

PROBLEMS involving combined two-directional Laplacian and Poissonian fields are encountered in many branches of science, such as heat transfer, electricity, fluid flow, physics, stress, and so on. The analytical solutions for problems of this sort are known for only the simplest geometric forms and boundary conditions. Whenever the geometry or boundary conditions become complex, the engineer or scientist must resort to numerical, graphical, or analog techniques.

The advent of atomic energy has suddenly increased the number and variety of these problems. The nature of the nuclear machine compels the scientist to predict very accurately what conditions will exist prior to actual operating experience. This they are doing only at the expense of much time and effort. The need for a quick, easy, inexpensive method of solving combined two-directional Laplacian and Poissonian field problems with complicated geometrical designs and boundary conditions has been re-emphasized by this new branch of engineering.

In this paper an electrical, geometrical analog is presented for the determination of (*a*) two-directional equipotential patterns of Poissonian fields created by uniformly distributed sources under steady-state conditions; and (*b*) the numerical value of those equipotential lines (isotherms), when the method is applied to heat-conduction problems.

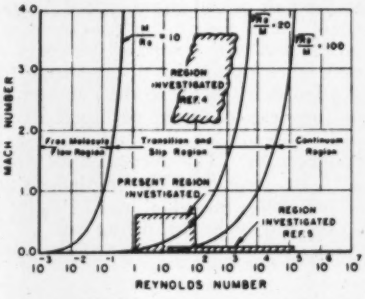
The analog consists of a resistive plotting surface that has geometrical similarity to the physical problem, a coupled resistor, a d-c source, and a null-type voltage-measuring device. The materials are relatively inexpensive and readily available. The circuit is simple and easily constructed.

The numerical values of the isothermal lines, when this analog is applied to two-directional heat-conduction problems, are obtained by direct measurement without evaluating the field by conformal mapping technique.

Heat Transfer From Spheres to a Rarefied Gas in Subsonic Flow, by L. L. Kavanau, University of California, Berkeley, Calif. 1954 ASME Semi-Annual Meeting paper No. 54—SA-52 (mimeographed; available to April 1, 1955).

THE calculation of convective heat transfer between a gas and an immersed body becomes increasingly difficult when the mean free path of the gas is not negligible compared to significant body dimensions. Occurrence of this gas rarefaction decreases the heat-transfer coefficient below its continuum value. This effect apparently is due primarily to the temperature-jump condition at the surface, analogous to the slip velocity at the surface, which occurs at low pressures. This temperature jump introduces an effective thermal-contact resistance at the surface.

Convective heat transfer from spheres to a rarefied gas has been treated analytically and experimentally in earlier references. Past experimental results give heat-transfer coefficients in the slip-flow region below continuum values. These results were determined under supersonic-flow conditions. Since there existed a curved detached shock wave, some doubt remained as to the effect of the shock wave and possibly other compressibility phenomena on the results. It was considered desirable to obtain heat-transfer data from spheres at subsonic Mach numbers in the slip-flow region.



The flow region of the present experimental investigation shown together with previously reported investigations

This paper presents over-all average heat-transfer data from spheres to a rarefied air stream where the Mach number and Reynolds number varied from 0.1 to 0.69 and 1.75 to 124, respectively. A simplified analysis which predicts the trends of these data by means of a rarefaction correction to the continuum solution is presented. Comparison of the analysis also is made with an existing closed-form solution for the heat transfer from a circular cylinder in rarefied gas flow.

Heat Transfer From a Rotating Plate, by R. L. Young, Assoc. Mem. ASME, Northwestern University, Evanston, Ill. 1954 ASME Semi-Annual Meeting paper No. 54—SA-51 (mimeographed; available to April 1, 1955).

EXPERIMENTAL values and comparisons with previously proposed analytical solutions are presented for the surface coefficient of heat transfer by convection from a rotating body.

The particular case investigated was

that of an upward-facing heated circular plate rotated in ambient air about a vertical axis normal to its surface.

It was observed that for Reynolds numbers less than 500,000 both natural and forced-convection phenomena were of importance, while at Reynolds numbers greater than 500,000 forced convection alone was of prime significance.

Curves and equations are presented which permit the calculation of heat transfer by convection from such a surface.

An Investigation of the Effect of a Step in the Surface Temperature on the Heat Transfer to a Laminar Boundary Layer, by L. J. Gee, Assoc. Mem. ASME, Detroit Controls Co., Redwood City, Calif., and R. A. Seban, Mem. ASME, University of California, Berkeley, Calif. 1954 ASME Semi-Annual Meeting paper No. 54—SA-54 (mimeographed; available to April 1, 1955).

Local heat-transfer coefficients have been determined experimentally for a surface upon which the boundary-layer flow was laminar and upon which there occurred a sudden increase in the surface temperature.

The boundary layer was formed by the flow of air over the surface of a plate and in most of the investigations the velocity was almost constant over the entire surface of the plate. Experimental conditions thus approached those of the analysis of Rubesin on the effect of a step in the surface temperature on the heat transfer from the surface of a flat plate at zero incidence to the stream. The experimental results show acceptable general correspondence with that theory.

A Note on Limiting Laminar Nusselt Number in Ducts With Constant Temperature Gradient by Analogy to Thin-Plate Theory, by S. M. Marco, Assoc. Mem. ASME, and L. S. Han, The Ohio State University, Columbus, Ohio. 1954 ASME Semi-Annual Meeting paper No. 54—SA-46 (mimeographed; available to April 1, 1955).

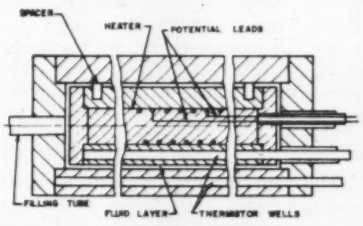
This paper points out that the existing solutions for the deflections of thin plates under uniform lateral load and simply supported along all edges can be applied to the determination of the limiting temperature distributions in a fluid flowing in laminar motion in ducts of the same cross sections as those of the plates. The direct application of this solution is permissible only when (*a*) the axial temperature gradient is constant, with respect to both flow length and cross-section position (this implies uniform heating or cooling); (*b*) the cross section is a polygon. When the cross-section boundary contains curves, the constants of integration must be adjusted so that the boundary condition of nonslip flow is satisfied. Since the temperature and velocity distributions obtained by this analogy are expressed analytically, values of local heat transfer at any point in the cross-section boundary can be calculated.

Examples are given for four cross-sections—rectangular, equilateral triangular, right-angled isoceles triangular, and semicircular. The heat-transfer distributions on the boundaries are calculated for square and equilateral triangular cross sections.

The Thermal Conductivity of Organic Liquids, by P. R. Pagerey, Taylor Instrument Co., Rochester, N. Y., C. R. St. Clair, Assoc. Mem. ASME, Motor Wheel Co., Lansing, Mich., and W. L. Sibbitt, Assoc. Mem. ASME, Purdue University, Lafayette, Ind. 1954 ASME Semi-Annual Meeting paper No. 54—SA-55 (mimeographed; available to April 1, 1955).

A primary instrument was constructed for the measurement of the thermal conductivity of liquids at atmospheric pressure. An aluminum instrument was constructed such that it used a liquid layer only 0.022 in. thick in order to eliminate the effects of convection.

Measurements were made over the approximate temperature range from 20 to 90 C with the following compounds: (1) Ethyl acetate, (2) vinyl acetate, (3) butyl acetate, (4) adiponitrile, (5) acrylonitrile (commercial), (6) distilled acrylonitrile, (7) dibutyl phthalate, (8) methyl methacrylate, (9) dimethyl formamide, and (10) dimethyl acetamide.



Details of the concentric cylinder-type test instrument. The cylinders were 24S aluminum, machined and polished so as to provide an annulus 0.022 in. wide. The concentricity of the cylinders was maintained by three small teflon pins spaced symmetrically about each end of the inner cylinder. Both cylinders were closed with teflon gaskets and with aluminum caps which were fastened securely with screws.

The experimental accuracy was estimated to be approximately ±2.5 per cent.

The Determination of Thermal Diffusivity of Aluminum Alloys at Various Temperatures by Means of a Moving Heat Source, by D. Rosenthal and N. E. Freidmann, University of California, Los Angeles, Calif. 1954 ASME Semi-Annual Meeting paper No. 54—SA-56 (mimeographed; available to April 1, 1955).

Previous work has demonstrated that the theory of moving heat sources can be used for a direct and rapid determination of thermal diffusivity in metals at high temperatures. Present work describes the experimental procedure and instrumentation which have been developed for metals of relatively high thermal diffusivity, 0.2 cm²/sec and more.

The method was applied to two aluminum alloys, 3S and 61S, which are commonly used for welding purposes. Therefore the results are believed to have practical significance. The thermal diffusivity of both alloys shows little or no increase with temperature from 150 to 1000 F.

To check the reliability of results the thermal diffusivity of a sample of deoxidized copper was determined, first by this method and then independently from its electrical resistivity using published data of the Franz-Wiedemann ratio for copper alloys. The two determinations agreed within ±1 per cent.

The results on aluminum alloys proved that values of thermal diffusivity, averaged over an interval of 100 deg F, can be determined easily to three significant figures. The reproducibility of individual results was found to be largely independent of the velocity and intensity of the heat source and the wall thickness of the specimens. It was of the order of ±2 per cent. However, six consecutive runs can be made readily within 2 or 3 hr, thus reducing the probable error to a much lower value.

A Systematic and Rapid Procedure of Computing Approximate Characteristic Values Pertaining to Bare-Tube Crossflow Heat Exchangers, by F. J. Neugebauer, Mem. ASME, General Electric Company, Schenectady, N. Y. 1954 ASME Semi-Annual Meeting paper No. 54—SA-40 (mimeographed; available to April 1, 1955).

This paper presents a systematic method of determining approximate characteristic values pertaining to crossflow heat exchangers of the bare-tube bundle type. Only the case of turbulent flow has been taken into consideration.

The method described allows rapid computation of entire families of heat exchangers having the same requirements with regard to heat-transfer and pressure losses. The basic idea of this method is not confined to the afore-mentioned type of heat exchanger and flow pattern. The method can be adapted to other configurations.

Heat-Exchanger Selection by Computation Machine Methods, by G. E. Eggleston, Assoc. Mem. ASME, and Donald E. Brimley, Mem. ASME, Douglas Aircraft Co., Santa Monica, Calif. 1954 ASME Semi-Annual Meeting paper No. 54—SA-47 (mimeographed; available to April 1, 1955).

THE problem of proper air-to-air heat-exchanger selection for an airplane is difficult and usually entails a large amount of calculation. The airplane designer is confronted with the problem of compromising weight, cooling-air drag power, and the power required to provide the pressure drop of the hot air being cooled with the dimensions of the heat exchanger.

To be able to select all factors intelligently the designer first must determine the critical flight condition of the airplane-take-off distance, maximum speed, or maximum range. The penalty to the airplane caused by the heat exchanger can then be minimized for the critical condition.

In addition to the foregoing variables the heat exchanger must be balanced against the rest of the airplane with due regard for space, ducting, and installation considerations.

In this paper air-to-air heat exchangers of given core geometry are selected for airplanes with regard to minimizing the penalty to the plane. Varying types of penalties are included. The method employs an IBM 701 data-processing machine for the solution of heat-transfer and penalty equations. The output is printed on sheets in three-dimensional form for ready visualization of the results.

Thermal Lags in Flowing Incompressible-Fluid Systems Containing Heat Capacitors, by J. W. Rizika, Harvard University, Cambridge, Mass. 1954 ASME Semi-Annual Meeting paper No. 54—SA-50 (mimeographed; available to April 1, 1955).

THE transient thermal conditions in problems involving flowing-fluid systems in contact with heat capacitors are becoming increasingly important with the advent of modern control techniques. The temperature controllability of a flowing-fluid system is a direct function of the transient thermal response of the fluid to a specific temperature input function.

In a previous paper the author presented an analysis which considered the transient fluid temperatures in a system consisting of a compressible fluid flowing through a duct or in a heat exchanger. The case of a compressible fluid, with an exponential or step-function fluid-temperature input, flowing through an insulated tube or pipe, was analyzed in detail and examples were presented. The treatment of the transient conditions for a compressible fluid flowing through a heat exchanger was partially analyzed and the method of solution was demonstrated.

This paper consists of an extension of the work in which the transient conditions resulting from thermal lags in flowing incompressible-fluid systems are analyzed. An example which demonstrates the transient condition at the exit of a simple (condensing—steam/water) heat exchanger is also presented.

Instruments and Regulators

Experimental Flight Methods for Evaluating Frequency-Response Characteristics of Aircraft, by G. A. Smith and W. C. Triplett, Ames Aeronautical Laboratory, National Advisory Committee for Aeronautics, Moffett Field, Calif. 1954 ASME Semi-Annual Meeting paper No. 54—SA-3 (in type; available to April 1, 1955; to be published in Trans. ASME).

THE extremely wide range of speeds and altitudes at which the latest aircraft operate leads to serious problems in stability and control. The difficulty experienced by the human pilot in coping with these problems has contributed greatly to the emphasis now being placed on the automatic interceptor and the guided missile which depend on high-performance autopilots for precise maneuvering control during combat operations. For the analysis of these complex systems which involve the dynamics of the air-frame, the frequency-response methods of servomechanism theory have been applied successfully.

This paper deals mainly with methods and techniques for obtaining airplane frequency-response characteristics from transient-flight measurements.

After a review of the basic airplane equations of motion, the theoretical transfer function which defines the "short-period" pitch response to an elevator deflection is derived.

A numerical example is used to illustrate the evaluation of an analytical transfer function from a graphical frequency response by a method which involves the use of graphical aids in conjunction with an analog computer.

Finally, the effects of variations in flight speed and altitude on the airplane response are considered.

The Frequency-Response Approach to the Design of a Mechanical Servo, by H. A. Helm, Bell Telephone Laboratories, Whippany, N. J. 1954 ASME Semi-Annual Meeting paper No. 54—SA-36 (in type; available to April 1, 1955; to be published in Trans. ASME).

THE frequency-response method of analysis has proved extremely valuable in the design of electronic feedback systems. This paper illustrates the application of this method to the design of completely mechanical systems.

Basic relations between the mechanical elements are pointed out and the necessary feedback concepts are developed for mechanical systems. These concepts are illustrated by the actual step-by-step design of an automatic contour-following lathe using entirely mechanical, hydraulic, and pneumatic control elements.

A Thermal Sine-Wave Apparatus for Testing Industrial Thermometers, by S. P. Higgins, Jr., Assoc. Mem. ASME, and J. R. Keim, Mem. ASME, Minneapolis-Honeywell Regulator Company, Philadelphia, Pa. 1954 ASME Semi-Annual Meeting paper No. 54—SA-20 (mimeographed; available to April 1, 1955).

THE problem of measuring fluid-temperature fluctuations accurately is essentially a problem in transient heat transfer. At present any serious study of this problem involves the use of carefully designed experimental apparatus.

This paper describes apparatus which provides thermal sine waves in a pipe to determine the frequency response of industrial temperature-measuring devices. Some test results are included and discussed to show the use of the apparatus.

Water from two constant-temperature storage tanks flows to a mixing valve and then to a pipe section in which the temperature-sensitive elements are located. The actual water temperature and response of the test element are recorded on a two-pen strip-chart potentiometer. Frequencies are varied over a range of 0.2 to 30 cpm. Amplitude and phase relationships are determined by measurements on the strip-chart records.

The apparatus permits the determination of the frequency-response characteristic of industrial temperature-measuring elements with water flowing parallel to the axis of the element. Flow is ad-

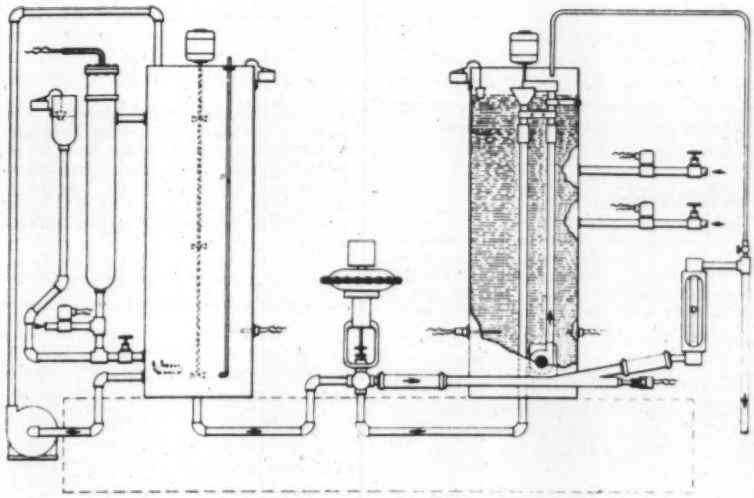


Diagram of water-handling equipment for the testing of industrial thermometers

justable over a range of 0.5 to 4.0 gpm, and at the maximum flow the water velocity is 2 fps, at which speed the water-to-metal heat-flow resistance usually becomes negligible in comparison to internal resistances.

The temperature wave form deteriorates as the frequency and amplitude increase. However, by restricting the temperature amplitude to 5-deg F adequate wave forms are available out to 30 cpm. This has proved sufficient for most industrial elements. If much faster units were to be studied it would be desirable to increase the maximum frequency. This could be done by improving the air-handling ability of the positioner-valve combination.

The apparatus permits closely reproducible test conditions since flow rate, frequency, temperature amplitude, and mean temperature can be adjusted and measured accurately. The frequency-response data obtained using the apparatus has proved useful in connection with investigations into the dynamic response of temperature elements.

A Thermal Sine-Wave Generator for Speed-of-Response Studies, by Robert Looney, Taylor Instrument Companies, Rochester, N. Y. 1954 ASME Semi-Annual Meeting paper No. 54—SA-28 (mimeographed; available to April 1, 1955).

THE investigation of the speed of thermal-measuring elements by the frequency-response method requires a sinusoidal input and a record of the periodic input and output.

This paper describes a thermal sine-wave generator using water as a fluid and includes frequency-response curves derived from test data. The generator has continuous adjustment of frequency from 0.75 cps to 0.0005 cps at a maximum flow velocity of about $1\frac{1}{2}$ fps. The flow velocity past the specimen being tested is adjustable.

The apparatus consists of two stainless-steel 90-gal water baths held at the respective temperatures of 123 F and 137 F by the use of pneumatic controls and valves, low-pressure steam, and tap water. Piping connects each bath with 2-in. flow valve and the flow valves are connected to a true Y pipe fitting. A centrifugal pump rated at 75 gpm is connected to the true Y outlet.

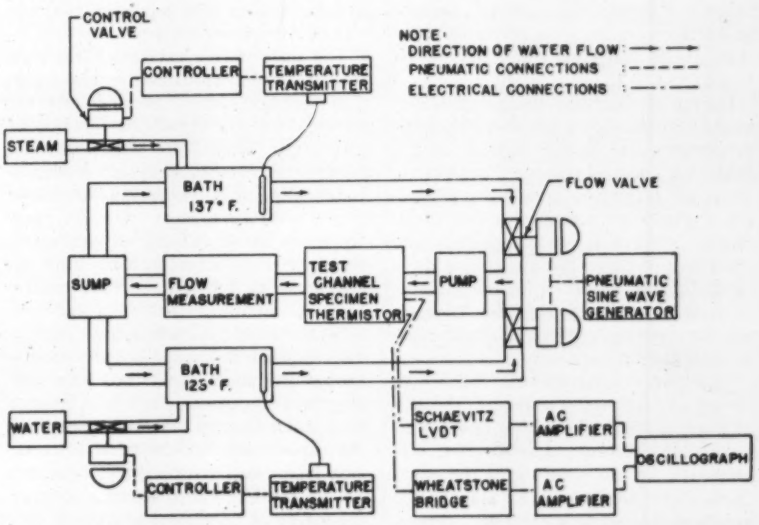
The generator has the disadvantages of high cost and complexity of operation. Thermal frequency response is time-consuming owing to the large amount of low-frequency operation.

The thermal bulb may be positioned either perpendicularly or parallel to fluid flow. Provisions have been made in the design by which future testing may be accomplished in pipe tees and ells.

Either step-response or frequency-response tests can be conducted with the apparatus under comparable flow and temperature conditions. Step-response curves are more easily obtainable than are frequency-response curves. Step-response information for a linear system may be transformed into the frequency domain by a rather involved mathematical treatment. However, the step-response information for some systems is not transformable because of nonlinearities and other eccentricities. Here frequency response offers the important advantage that the frequency-response plots are more directly usable than the step-response curves. The Bode plot is of immediate use in the application of servomechanism techniques to process control.

The Dynamics of Filled Temperature-Measuring Systems, by Otto Muller-Girard, Taylor Instrument Companies, Rochester, N. Y. 1954 ASME Semi-Annual Meeting paper No. 54—SA-29 (mimeographed; available to April 1, 1955; to be published in Trans. ASME).

THE response equations of a two-time-constant interacting network as applied to liquid-filled tube systems are developed. The solutions to a unit step,



Block diagram of a thermal sine-wave generator for speed-of-response studies

ramp, and sinusoidal temperature input are given.

Some practical aspects of response work based on experiments with mercury-filled thermal systems are presented A few recommendations concerning the specification of the speed of response are included.

Differential-Analyzer Study of a Nonlinear Hydraulic Servomechanism, by G. A. Bekey, University of California, Los Angeles, Calif., and J. T. Ahlin, IBM Corp., Los Angeles, Calif. 1954 ASME Semi-Annual Meeting paper No. 54—SA-4 (mimeographed; available to April 1, 1955).

DURING the past decade great impetus has been given to the development of flow-valve controlled hydraulic servomechanisms by urgent requirements for greater accuracy and speed of response. These requirements have been especially urgent in the field of aircraft research and development. An important factor in the success of these new servomechanisms was the introduction of nonlinear elements into their design. However, the use of nonlinear elements has created many new problems, the major one of which is the extreme difficulty encountered in solving the associated nonlinear differential equations. When applicable, phase-plane and phase-space analyses used with servo problems give a qualitative understanding of the effects of the nonlinear elements. Unfortunately, the science of nonlinear analysis is not developed to the point where all systems of differential equations can be studied in this manner. In view of the difficulty of handling nonlinear problems and the urgency of developing accurate, rapid response servomechanisms, methods other than direct analytical solution must be found to assist in servo design.

During the present period of servomechanism development, widespread advancements also have been made in the field of general-purpose computers. These advancements permit the practicing engineer to determine quickly the effects of servo-design changes by the technique of parameter variation. It is often difficult, however, for the engineer to avail himself of information concerning the existing computers, their capabilities, and limitations.

This paper indicates the manner in which one of these computers, the mechanical differential analyzer of the University of California, Los Angeles, was employed for the solution of the equations of motion describing a hydraulic servo with nonlinear elements. Inherent in the description of the solution is a presentation of some of the machine's capabilities and limitations.

The main emphasis is placed on the ability of the differential analyzer to handle a problem of this type, rather than on the actual physical system.

Lubrication

Mechanism of Fretting Corrosion, by H. H. Uhlig, Massachusetts Intistute of Technology, Cambridge, Mass. 1954 ASME Semi-Annual Meeting paper No. 54—SA-5 (in type; available to April 1, 1955; to be published in the *Journal of Applied Mechanics*).

A REVIEW of the facts suggests that the mechanism of fretting corrosion includes a chemical factor and a mechanical factor, with observed damage, in general, resulting from both.

An asperity rubbing on a metal surface is considered to produce a track of clean metal which immediately oxidizes, or upon which gas rapidly adsorbs. The next asperity wipes off the oxide or initiates reaction of metal with adsorbed gas to form oxide. This is the so-called chemical factor of fretting.

In addition, asperities dig below the surface to cause a certain amount of wear by welding or shearing action in which metal particles are dislodged. This is the mechanical factor of fretting.

Metallic debris produced by fretting is thought not to oxidize spontaneously, as proposed by the molecular-attrition theory, but instead converts partially to iron oxide by secondary fretting action of particles rubbing against themselves or adjacent surfaces. This accounts for the fact that Fe_2O_3 is found by x ray to be the major corrosion product and metallic iron is present, if at all, in only very small amount.

The quantitative expression for fretting corrosion is derived. The equation predicts that fretting-corrosion weight loss is a hyperbolic function of frequency, is parabolic with load, and linear with number of cycles or magnitude of slip. Furthermore, the terms concerned with a frequency effect disappear when the chemical factor is suppressed, as is observed when fretting tests are conducted in nitrogen. These conclusions are confirmed by the reported data.

In addition, the calculated reaction-rate constant for oxidation of a freshly formed iron surface obtained from fretting data is reasonable and falls between two independently observed values. In the experiments, the chemical or corrosion factor falls within 6 to 78 per cent of the total observed fretting damage, depending on conditions of test.

Remedial measures are outlined in light of the data and the proposed mechanism.

Fretting Corrosion of Mild Steel in Air and in Nitrogen, by I-Ming Feng and H. H. Uhlig, Massachusetts Institute of Technology, Cambridge, Mass. 1954 ASME Semi-Annual Meeting paper No. 54—SA-6 (in type; available to April 1, 1955; to be published in the *Journal of Applied Mechanics*).

DATA are presented on fretting corrosion of mild steel using weight loss as a measure of damage.

Relative slip was measured both by use of stroboscopic light and strain gages. Load was applied pneumatically. Humidity of ambient air was found to be a sensitive variable requiring control, a fact first discovered through discrepancies of weight-loss data obtained in winter compared with those obtained in summer.

Fretting corrosion of mild steel in moist air is only 55 to 65 per cent of the weight loss in dry air, depending on duration of test. Because of this large difference, all tests were carried out in dry air. At the same time it was observed that fretting corrosion is appreciably greater below room temperature than above room temperature (up to 150 C). Weight losses of specimens fretted at 50 C approximately are 50 per cent losses at 0 C.

Rate of fretting corrosion in air is found to be constant with time after an initial run-in period during which the rate is temporarily higher. In moist or dry nitrogen, weight losses are much less, although not zero. The greater the relative slip, the greater is fretting damage, and in complete absence of slip the data indicate that no weight loss occurs. Increased pressure or load is found to increase fretting damage. Weight loss is greater the lower the frequency for the same number of test cycles. The frequency effect increases with relative slip, and in nitrogen the frequency effect disappears.

Prediction of Lubricating-Oil Viscosities at High Pressures, by O. H. Clark, Socony-Vacuum Laboratories, Paulsboro, N. J. 1954 ASME Semi-Annual Meeting paper No. 54—SA-39 (mimeographed; available to April 1, 1955).

THERE exists a degree of correlation between the effects of temperature and of pressure upon the viscosity of oils. This correlation makes it attractive to attempt to predict the variation of viscosity with pressure from its variation with temperature. The feasibility of

such prediction on lubricating oils has been difficult to appraise because of insufficient data. The ASME project on high-pressure viscosities has recently reported an extensive set of such measurements.

In this paper data from the ASME project have been applied to test the feasibility of predicting viscosity at high pressures from room-pressure measurements at 100 and 210 F. For ASME test oils graphical relations were developed to predict viscosities up to about 50,000 psi at 100 and 210 F. Two scales were used, according as oils were classified as paraffinic or naphthenic. Discrepancies between measured and predicted values are noted and discussed.

Machine Design

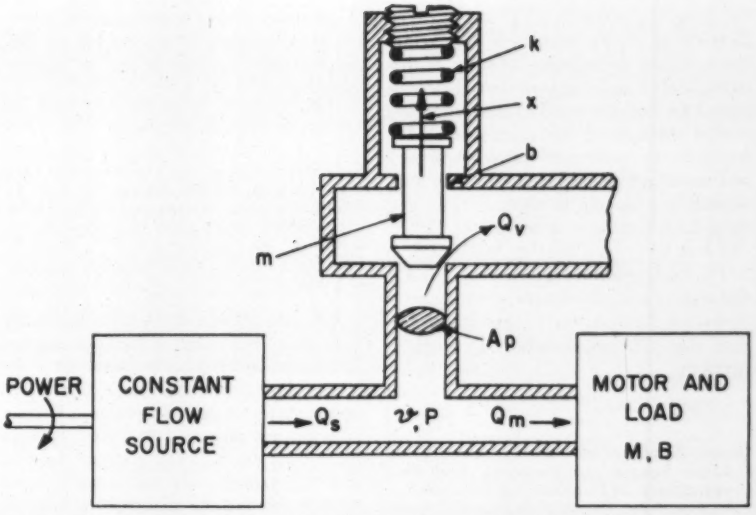
On the Dynamics of Pressure-Controlled Hydraulic Systems, by Gerhard Reethof, Assoc. Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1954 ASME Semi-Annual Meeting paper No. 54—SA-7 (multilithographed; available to April 1, 1955).

In the design of complex hydraulic systems the questions of speed of response and stability are of paramount importance. The heavy landing gear of an aircraft in flight should move quickly and without excessive oscillation into the desired position; the machine-tool table must traverse without hydraulically induced vibrations. Furthermore, if such systems are disturbed during their operation, such as by wind gusts for the case of the landing gear or by load changes on the cutting tool, they should reach the steady-state condition rapidly without excessive oscillation. A typical hydraulic system may consist of a positive-displacement pump driven by a prime mover, the combination representing essentially a constant-flow source, a pressure-limiting or pressure-regulating device, a flow-control valve, and the load to be moved. The load may be located at some distance from the pressure source, necessitating the motion of a long fluid column between the pressure source and the load.

Problems in the design of such a system include the proper selection of commercially available components, the development of new components as needed, and the choice of optimum system characteristics to insure the desired dynamic operation of the over-all system. Much insight into the problem can be gained by an analytical study supplemented by such modern tools as the electronic-analog computer.

In this paper the dynamics of a general pressure-controlled hydraulic system are investigated by analytical means. It is shown that the system is essentially a closed-loop control system and that an important interaction between the various components of the system exists.

Stability criteria for the system based on Routh's discriminant are presented and the influence of the various physical constants of the system is discussed.



Schematic drawing of a general-type pressure-controlled hydraulic system

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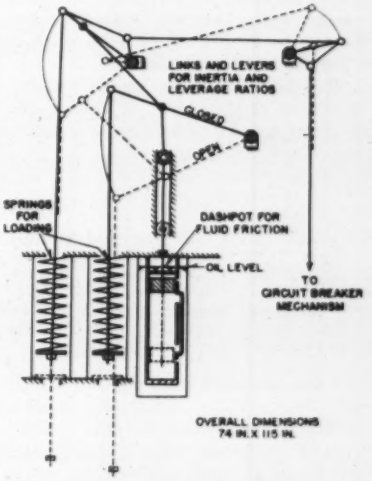
A Loading Fixture for Testing Power-Circuit-Breaker Mechanisms, by R. C. Van Sickle, Westinghouse Electric Corporation, East Pittsburgh, Pa. 1954 ASME Semi-Annual Meeting paper No. 54—SA-18 (multilithographed; available to April 1, 1955).

Building a loading fixture made possible completing the development testing of a pneumatic operating mechanism before the construction of a large power circuit breaker on which it was to be used. The loading fixture with fewer elements simulates the moving parts of the breaker with respect to biasing forces, inertia, and fluid friction. The matching of the inertia which varies throughout the stroke is particularly important because about one fourth of the energy supplied on closing is transformed into kinetic energy.

The testing fixture occupies a floor space about 5 × 8 ft and stands 11 ft high. The spring loads are supplied by two springs acting on different levers and picked up at different points in the closing stroke. A dashpot provides a fluid friction simulating the movement of the contact cross arms through the oil; at the end of the closing stroke the retarding force is increased to simulate the charging of the oil pumps. During the opening stroke the retarding force is high at the start to simulate the load of the oil pumps, becomes less to simulate the friction of the moving cross arm after the oil pumps have reached the end of their stroke, and again increases to bring the moving parts to rest at the end of the opening stroke. This is accomplished by a double-acting dashpot with an adjustable by-pass to reduce the friction during the middle of the stroke. It is contained in an oil tank. Baffles and an oil separator in the vent pipe eliminate the throwing of oil.

Over 5000 operations were made in



Operating parts of loading fixture for testing power-circuit-breaker mechanisms are shown in this schematic

checking the performance of the various elements in the mechanism, in improving the design or performance of some of the parts, and in making sure that the completed mechanism would function as intended throughout the ranges of loads, frictions, air pressures, control voltage, and sequences of operations to which it would be subjected in service. The development testing was completed before the first three-pole breaker was built.

The loading fixture is now available for the testing and adjustment of subsequent operating mechanisms of this design before they are assembled into complete breakers.

Some Applications of the Theory of Least Squares to Research and Development of Engineering Equipment, by J. A. Folse, Bureau of Aeronautics, Navy Department, Washington, D. C. 1954 ASME Semi-Annual Meeting paper No. 54—SA-11 (multilithographed; available to April 1, 1955).

THE theory of least squares is applied to the problem of increasing the horsepower capacity of an aircraft oil hydraulic pump while minimizing its increase in weight. Data on a fixed-displacement type of pump of one manufacturer are analyzed by use of an approximate expression of weight in terms of pressure, flow, and speed. The results indicate that minimum-weight increase is obtained by increasing pressure rather than rotative speed in going to higher horsepower ratings.

In another illustration the law of propagation of errors is applied to show that in writing specifications the tolerances placed on the dependent and independent variables of a function, such as torque, cannot be arbitrarily assigned without incurring needless waste.

This paper illustrates some simple applications of the theory of least squares to research and development of engineering equipment.

Dynamic Loads on Spur and Helical-Gear Teeth, by J. B. Reswick, Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1954 ASME Semi-Annual Meeting paper No. 54—SA-9 (in type; available to April 1, 1955; to be published in Trans. ASME).

A SIMPLE model gives physical insight into the dynamic behavior of gears. Relationships developed from consideration of this model indicate that design criteria are significantly different in heavily loaded gears than in those which are very lightly loaded.

Results show that dynamic loads may be ignored in many heavily loaded gears, but that dynamic loads provide an important basis for the design of lightly loaded gears.

Safe Stress Range for Deformation Due to Fatigue, by M. Kawamoto and K. Nishioka, Kyoto University, Kyoto, Japan. 1954 ASME Semi-Annual Meeting paper No. 54—SA-10 (multilithographed; available to April 1, 1955; to be published in Trans. ASME).

THE safe stress range of materials for fatigue is determined from both fatigue destruction and fatigue deformation. On fatigue destruction there have been many investigations hitherto, while on fatigue deformation only a few investigations have been made. The authors believe that the safe stress range, usually considered for fatigue deformation, is incorrect for some materials. The paper discusses this matter as it presented itself in the experiments.

Experiments were made on two carbon steels and two spring steels. These two carbon steels and the spring steel SUP4 were applied to repeated torsion tests, and the spring steel SUP3 was exposed to repeated bending tests (plane bending).

Testing machines, used for these tests, were driven at 2000 to 2600 rpm, and stopped at some intervals to measure the deformation of specimens. Measurements were made statically by the optical-lever method with the mirrors attached at both ends of gage length.

The paper concludes that in materials with clear yield points the fatigue yield points coincide with the static yield points, while in materials without clear yield points, the fatigue yield points or fatigue elastic limits are lower than those in static tests. Therefore, in the latter case, the safe stress range for fatigue deformation must be smaller than that usually accepted, and it can be represented by the constants proposed by the authors.

The Wear and Friction Properties of Materials Operated in High-Temperature Water, by R. C. Westphal and J. Glatter, Westinghouse Electric Corporation, Pittsburgh, Pa. 1954 ASME Semi-Annual Meeting paper No. 54—SA-13 (multilithographed; available to April 1, 1955).

IN a nuclear power plant designed for the propulsion of a submarine, many mechanical devices operating under unusual conditions are required. These devices require the execution of rotary and translatory motions at low rates of speed in high-temperature high-purity water. Specifically, components such as anti-friction bearings, linear sliding guide bearings, latches, valve parts and actuators, and even nuts and bolts must be considered. The absence of any lubrication other than the water poses a problem of considerable magnitude with regard to the wear of materials having adequate corrosion resistance. The choice of materials for use in mechanisms must therefore be governed by the possession of a combination of properties involving both wear and corrosion resistance. Early in 1951 a simulated-wear test program was initiated at the Atomic Power Division of Westinghouse for the purpose of selecting materials suitable for nuclear-reactor mechanisms.

The purpose of the investigation discussed in this paper was to discover combinations of materials which could be used successfully for bearings operating in 500 F water. Test apparatus is described which was constructed for the evaluation of the wearing properties of materials combinations under this condition.

Representative results are reported which cover the range of experimental values observed. These results are discussed with regard to the influence of several variables upon the mechanisms of wear. A brief study of friction and solid film lubricants is included.

Two types of tests were chosen as being representative of the sliding motions expected in service. One was a piston-and-cylinder combination involving pure linear motion. The other was a sleeve-bearings-and-journal combination which gave rotary motion.

Aviation

Experience With Turbojet Lubrication Systems, by L. E. Goodding and J. L. Hatch, General Electric Company, Cincinnati, Ohio. 1954 ASME Semi-Annual Meeting paper No. 54—SA-76 (multilithographed; available to April 1, 1955).

GOOD jet-engine oil systems are not designed by chance. They require careful design consideration, component test, flight test, and finally service test to establish their merit. Too often in the past, oil systems have begun as simple compact designs but have become complex as "fixes" are added. Deficiencies have arisen because of lack of information, or because of the complexities involved in combining a complete system made up of components from the engine manufacturer, the aircraft manufacturer, and the accessory manufacturer.

This paper describes several turbojet-engine lubrication systems developed since the beginning of the jet-engine era, pointing out possible advantages, dis-

advantages, deficiencies, and refinements of the various systems.

All turbojet oil systems must be designed to meet two basic requirements:

1 The system must supply ample oil flow to the engine at all operating altitudes and attitudes which the aircraft may assume.

2 The system must be fully operable under all climatic conditions encountered anywhere in the world.

Throughout the decade during which turbojet engines have been produced, the changes in lube systems have been based upon experience factors rather than upon new theories or drastic changes in configurations. The philosophy that systems utilizing solid oil jets and multiple-element pumps are fundamentally sound is substantiated by the impressive total of operational time in the field and in the factory.

Difficulties which were encountered when this basic type of system was employed were generally common to the system and grade of lubricant or due to a particular feature of the engine configuration. Such problems, while troublesome, have not been insurmountable. Loss in performance at altitude, excessive foaming and aeration, and related effects have been overcome by pressurization of tanks and sumps, gear shrouding, baffling, and other modifications. Mechanical features, including seal design, orifice diameters, sump size, and related items can be modified as required.

Although past experience can be utilized to a maximum extent when designing a new system, many problems, particularly those related to the installation, cannot be completely foreseen. Only actual flight testing will reveal the more obscure shortcomings of any lubrication system.

Process Industries

A Graphical Representation of the Frictional Losses in Commercial Pipe of Air and Steam Flowing Turbulently at Low Pressure, by W. C. Knapp and J. W. Metzger, Mem. ASME, C. H. Wheeler Manufacturing Company, Philadelphia, Pa. 1954 ASME Semi-Annual Meeting paper No. 54—SA-17 (multilithographed; available to April 1, 1955; to be published in Trans. ASME).

FREQUENTLY, design investigations in the field of fluid flow require the rapid evaluation of pressure losses in pipes at various conditions of temperature and pressure. This discussion presents a graphical solution for determining frictional losses in pipes of various sizes carrying air and steam, together with the mathematical analysis from which it is evolved.

Similar investigations, carried out for other fluids, may yield comparable graphical solutions, the utilization of which would aid materially in increasing the usefulness of fluid-flow data.

Fanning-Friction Factors for Air Flow at Low Absolute Pressure in Cylindrical Pipes, by W. J. Bohnet, Electro-Metallurgical Company, Niagara Falls, N. Y., and L. S. Stinson, Elliott Company, Jeannette, Pa. 1954 ASME Semi-Annual Meeting paper No. 54—SA-16 (mimeographed; available to April 1, 1955; to be published in Trans. ASME).

As there are no published data verifying the theoretical fanning-friction factors for streamline flow of air at low absolute pressures, an investigation was made of the pressure drops in 6 to 18-in-diam pipe lines in which room-temperature air was flowing at absolute pressures varying from 50 microns Hg to 1 mm Hg. The large number of pressure-drop readings taken at various rates of flow permits developing friction-factor curves for this type of flow. These are presented in the paper.

ASME Transactions for August, 1954

THE August, 1954, issue of the Transactions of the ASME (available at $1 per copy to ASME members, $1.50 to nonmembers) contains the following:

Technical Papers

Coefficients of Float-Type Variable-Area Flowmeters, by V. P. Head. (53—A-208)

Small Nozzles and Low Values of Diameter Ratio, by H. S. Bean, R. M. Johnson, and T. R. Blakeslee. (53—A-155)

Boiler and Furnace Designed for Spreader-Stoker Firing, by L. H. Coykendall and P. R. Loughin. (53—A-136)

Mechanical Analog-Computing Elements and Their Applications to Automatic Control, by Alvin Piatt. (53—A-141)

Proportional Control of Rate-Type Servomotors, by J. L. Shearer. (53—A-146)

Dynamic Characteristics of Valve-Controlled Hydraulic Servomotors, by J. L. Shearer. (53—A-147)

Contributions to Hydraulic Control—6, by Shih-Ying Lee. (53—A-139)

Evaluation of Transient Temperatures and Stresses, by R. J. Fritz. (53—A-75)

Apparatus for Study of Effects of Cyclic Thermal Stresses on Ductile Metals, by L. F. Coffin, Jr., and R. P. Wesley. (53—A-77)

A Study of the Effects of Cyclic Thermal Stresses on a Ductile Metal, by L. F. Coffin, Jr. (53—A-76)

Evaluation of Bandsaw Performance, by L. V. Colwell and R. E. McKee. (53—A-165)

The Momentum Principle Measures Mass Rate of Flow, by V. A. Orlando and F. B. Jennings.

The Viscosity, Thermal Conductivity, and Prandtl Number for Air, O_2, N_2, NO, H_2, CO, CO_2, H_2O, He, and A, by Joseph Hilsenrath and Y. S. Touloukian. (53—A-186)

Measurement of the Viscosity of Five Gases at Elevated Pressures by the Oscillating-Disk Method, by J. Kestin and K. Pilarczyk. (53—A-67)

Compressibility of Gases—VIII, by E. Whalley and W. G. Schneider. (53—A-85)

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Comments on Papers

Including Letters From Readers on Miscellaneous Subjects

Railroad Car Wheels

Comment by G. L. Cotter[1]

The author has done an excellent job[2] of analyzing the various factors affecting the performance of locomotive and passenger-car wheels and I can find little to quarrel with in the several figures he has cited. The extreme values of energy destruction during braking for diesel-locomotive wheels are modified somewhat by the fact that few diesel locomotives are braked as high as the trailing cars. Also, there is a general tendency among enginemen to reduce the braking on locomotives so that some of the locomotive energy is dissipated by the car wheels. Of course this means that the energy absorbed by the car wheels is even greater than the author has indicated.

Fortunately, emergency stops are rather rare and few trains are brought to a complete stop from high speed at the maximum retardation permitted by the service brake. The high retarding force available usually is held in reserve for emergencies or used only to save time in slowdowns for speed restrictions.

Wheel Failures Are Infrequent

Nevertheless, a passenger-car wheel is called on to absorb considerable punishment and it is gratifying to note from the author's closing remarks that while wheel failures are infrequent, the manufacturers are conducting research continually in order to make their product better able to stand service requirements.

Both Mr. Johnsen of the Pullman Company, and Mr. Garin of the Southern Pacific Company, have confirmed the fact that there are few wheel failures when proper wheels are selected for the service involved and adequate maintenance methods are followed. It is my opinion that wheels which will take the rolling load normally will handle the braking load. There have been many cases where wheels not subject to braking load and others with relatively light braking load have developed cracks similar to thermal cracks.

I can heartily endorse all that has been said regarding the need for proper maintenance of brake equipment and brake rigging for cars in high-speed service and feel sure that the railroads will be well repaid for all expenditures in that direction.

Wheel Heating

In his remarks about wheel heating the author describes the braking sequence which leads to thermal cracking. I would like to elaborate on that somewhat. The normal action of cast-iron brake shoes upon wheels is to contact the wheels at any instant over greatly limited but constantly changing areas. Therefore the generation of frictional heat is produced in a number of small spots around the tread surface. Under extreme conditions these spots may be sufficiently hot to glow and give the impression of a fire band on a rotating wheel. The intense heat concentration at these spots resulting from the limited area of contact may cause sufficient temperature gradient to produce the phenomenon mentioned by the author, terminating in thermal cracks. Any improvement in the shoe bearing on the wheel reduces the tendency toward thermal cracking and proper brake-rigging maintenance is a big step in that direction. It is also of interest to note that thermal cracks have developed in flat spots caused by wheel-sliding at high speeds, probably resulting from stresses induced by high temperatures produced at that time. Antislide wheel protection is helpful in eliminating such failures.

Comment by C. L. Eksergian[3]

The author is to be commended for his comprehensive review of the thermal duty which a wheel must face when associated with the tread brake. The paper also ably reveals the thermal conditions to which the tread, particularly, is subjected, accounting for the possible damage and failure which may result.

With the clasp brake it is physically impossible to retard main-line trains, traveling 100 mph, at a rate permitted by rail adhesion (3 mphps) without incurring high temperatures of shoe and tread surfaces which together are likely to cause thermal damage and possible wheel failure.

With wheel adhesion as low as it is, it follows that retardation in emergency most certainly should utilize the adhesion which at least is available. Hence we must expect to meet such retardation rates.

The author refers to an "average rate of 415 hp—over the entire distance of the stop." Actually, we are concerned with peak conditions rather than average. For the same average or mean horsepower, different peak horsepowers may obtain, depending upon the deceleration produced at high speed.

Deceleration From High Speed

What counts is the deceleration at high speed rather than what may be developed in the lower speeds when power demands are less exacting.

High-speed deceleration defines the peak power which the brake must handle—or the maximum rate at which heat is generated on the engaging surfaces.

The other critical factor is the "duration" at which peak conditions prevail, as defined by the "amount" of heat which must be handled at these high rates.

It will be observed that for a given braking ratio, the wheel load defines the shoe pressure and therefore torque (within the range of friction variation) and accordingly power—at a given speed.

Note, however, that the wheel load does not necessarily represent the mass which the brake must handle and which accordingly defines the duration of a given power bracket, or the amount of heat generated therein.

With modern high power-weight ratios (3–4 hp/ton), the locomotive is likely to weigh better than 40 per cent of the total train weight (cars plus locomotive) with an independent high-speed retardation of only 50 per cent of that of

[1] Director of Engineering, Air Brake Division, Westinghouse Air Brake Company, Wilmerding, Pa. Mem. ASME.

[2] "The Wheel Manufacturer Looks at Railroading," by C. B. Bryant, MECHANICAL ENGINEERING, vol. 76, March, 1954, pp. 255–258, 263.

[3] Executive Engineer, The Budd Company, Philadelphia, Pa. Mem. ASME.

the disk-braked cars, and 65 per cent for clasp-braked cars.

Accordingly, the inertia load which the car brake must handle at critical high speed, amounts to 25 per cent more than the wheel load for the disk-braked cars. This is derived from the fact that the train deceleration (because of the underbraked heavy locomotive) is 80 per cent of the rate at which the cars would stop by themselves. Hence, for the same torque (car brake) to produce only 80 per cent of the independent deceleration, means that the mass which the brake handles must be greater than the wheel load by 25 per cent.

A Practical Example

Specifically, a case at point is found in a main-line transcontinental train with disk-braked cars. The wheel load approximates 20,000 lb and the inertia load 25,000 lb. The free-car deceleration in emergency is 3 mphps—continuous from 100 mph.

Here the peak brake power is 750 hp per wheel—or 6000 hp per car—at 100 mph. If the cars could stop by themselves, within 10 sec, the speed would be reduced to 70 mph and the individual brake power cut to 525 hp. Thus the natural heritage of the brake—that of relieving itself by its own work—would be realized.

However, because of the 25 per cent overload, the duration in this critical speed bracket is increased to 12.5 sec; which means more time for temperature rise and therefore higher final temperatures.

At first blush, this difference in time may not appear significant.

In answer, it is to be pointed out that we are dealing with very sharp temperature gradients which rise most abruptly. Beyond this, the final temperatures may reach the zone of the plastic state, so that a matter of one or two hundred degrees may be the difference between critical and noncritical operation.

Heat Generated on Brake Surface

Some idea of the enormous rate at which heat is generated on the surface of shoe and tread is shown in the following:

At 100 mph, a 36-in. wheel is turning 940 rpm, or 15.6 rps, so that a 1 sq in. increment area on the tread surface is traveling roughly 150 fps.

The rail retarding force to produce a deceleration of 3 mphps with a wheel load of 20,000 lb is approximately 0.14 $\times$ 20,000 = 2800 lb. Therefore each of the two shoes must produce a tangential force of 1400 lb—or 22 psi of shoe area (assuming 16-in. $\times$ 4-in. shoe).

Thus, when the increment area on the tread passes under the shoe, the rate of work done is 22 $\times$ 150 = 3300 ft-lb/-sq in/sec—or 4.3 Btu/sq in/sec.

Since this rate prevails for only 0.01 sec (approximately) the quantity of heat generated in one pass amounts to 0.043 Btu/sq in. (approximately).

However, most of this heat must be removed from the surface within the next 0.02 sec—before the increment passes under the opposite shoe—if the temperature rise is to be held in moderation under such rapid succession of work. Thus the rate of heat removed must be in the order of 2 Btu/sq in/sec—a very high rate indeed!

Since heat travels by radiation and convection relatively slowly, we have only conduction to count on for transferring the heat from the surface into the walls of shoe and tread, respectively, at the rapid rate required.

Because of the low mass of the shoe as compared to the wheel—and more particularly the tread—the temperature of the shoe surface climbs much faster, particularly at the beginning. Thus a temperature head exists between shoe surface and tread surface, which causes the heat to "hug" the tread more closely while under the shoe. That which does not enter the shoe enters the tread as it leaves one shoe on its way to the other. The fact that more heat enters the tread is a salvation for the shoe, but, on the other hand, imposes a hardship on the wheel.

Because the heat is generated on only a filament surface—and at such a terrific rate—a sharp temperature gradient results across successive layers of the tread.

Plastic Upset

Because the surface and near-surface temperatures lie in the plastic region, efforts of increment layers to expand circumferentially are thwarted by the underlying colder annuli, with the result that circumferential plastic upset occurs.

Upon cooling, the upset increment attempts to return to the cold state of its new shape which is shorter circumferentially and higher radially. However, the very subsurface annuli which prevented expansion now prevent contraction—with one fundamental difference.

Whereas plastic upset was accomplished readily because of the high temperature, upon cooling elasticity is restored wherein the strain rate is small as compared to that required to compensate for the thermal extension. Consequently, high residual strains result, which can cause cracks or heat checks, as the author points out.

This explains why the rim surface becomes under a state of tensile strain, with the inner layers under compression.

Because the foregoing conditions and phenomena are basic, there can be expected little relief—so long as the wheel is called upon to serve as the drum of the brake.

The material of this paper points to one obvious solution: Remove the shoes from the wheel and provide an individual rotating member for the brake, as has been done with the disk brake.

In this way both shoe and disk can be designed and can employ materials most suitable for braking requirements—without the necessary forfeitures required when compromise is made—as is the case when the wheel is called upon to serve the dual functions of load-carrying member and brake member.

Author's Closure

The author is very appreciative of the comments offered by Messrs. Cotter and Eksergian. Both have amplified and emphasized the necessity of careful mechanical maintenance and control of braking practices. With the increased demands of present-day railroading, these points cannot be too strongly emphasized.

Charles B. Bryant.[4]

"Engineer's Prayer"

Teach me, as a Professional Engineer, to constantly search for the Truth and to direct my best Judgment toward the building of worthy goals.

Inspire me to broaden and deepen my knowledge. Help me to grow in wisdom so I can apply it with a growing understanding of spiritual, social, and cultural values.

Encourage me to be sincere, understanding, and co-operative in all my relationships—so that I can best promote the dignity and well-being of mankind.

Keep me humble, anxious, and strong in my purpose to contribute fully in working out the highest destiny of my profession.

Erhardt C. Koerper.[5]

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[4] Chief Engineer, Technical Board of the Wrought Steel Wheel Industry, Chicago, Ill.

[5] Work Manager, Ampco Metal, Inc., Milwaukee, Wis. Assoc. Mem. ASME.

Reviews of Books

And Notes on Books Received in Engineering Societies Library

Engineering Steels

ENGINEERING STEELS. By Leslie Aitchison and William I. Pumphrey. Macdonald and Evans, Ltd., London, England, 1953. Cloth, 5¼ × 8½ in., bibliography, 224 figs., 162 tables, appendixes, index, xxxiv and 923 pp., £5.5.0. (The British Book Center, New York, N. Y., $14.75.)

Reviewed by Frank T. Sisco[1]

THIS is an impressive volume, which is to be expected; for the authors are leaders in metallurgy in England. Their names have been synonymous with metallurgical education for a long time and their technical reports are well known throughout the world. To this reviewer's knowledge this is Professor Aitchison's first book on ferrous metallurgy (he has written at least two on nonferrous alloys); but he has been interested in the iron-rich alloys for many years. In fact, his first reports of research, published before and just after World War I, were on the corrosion of steel and on aircraft steels and heavy forgings.

This volume contains so much of value that it would be difficult to describe its contents without becoming tedious, which the book itself never does. It takes in the whole field of ferrous metallurgy from melting, casting, and mechanical working through thermal treatment (including hardenability) and mechanical properties, and their determination, to welding, machinability, and corrosion. Unalloyed carbon steels, low-alloy steels, and the whole gamut of high-alloy steels are covered.

The final chapter, a summary entitled "The Heart of the Matter," in which the authors contrast the facts about steel with the assumptions engineers make about this useful metal, is a gem; and this reviewer knows of no better service that ASME could render to the engineering profession than to reproduce this 32-page discussion and mail it gratis to its membership. It should also be required reading for every engineering undergraduate.

For American engineers the book has the customary faults of British textbooks, temperatures in degrees C only, tensile properties in tons per square inch, and very few references to research reports published in American journals. For example, in the brief discussion of brittle/ductile behavior in welded sections there is nothing on the Kinzel or Lehigh bend test, and the transition from ductile to brittle fracture is not mentioned. This is remarkable in view of the fact that the junior author is research manager of Murex Welding Processes, Ltd.

An additional block over which this reviewer stumbled was that the authors, after describing in detail the methods of making notched-bar impact tests, neglected in their tables of impact properties to give either the method or the notch used. Another point which will make American metallurgists smile is that the authors describe *troostite*, a metallographic constituent whose unmourned decease occurred many years ago, in considerable detail but dismiss *bainite* with the following: "along the shoulder of the [Jominy] curve . . . the structure changes because of the appearance of troostite or bainite."

[1] Director, The Engineering Foundation, New York, N. Y.

Books Received in Library...

ANTRIEBSELEMENTE. (VDI-Tagungsheft 2.) Verein Deutscher Ingenieure. Deutscher Ingenieur-Verlag, Düsseldorf, Germany, 1953. 188 p., 8¼ × 5¾ in., paper. 11.50 DM. This conference symposium on drive elements contains eighteen papers dealing with current problems involved in the making or application of bearings, couplings, gears and gearing. It also reviews the current status of research and development in the field.

ASME HANDBOOK. Metal Properties. Edited by Samuel L. Hoyt. Sponsored by Metals Engineering Handbook Board of The American Society of Mechanical Engineers, McGraw-Hill Book Company, Inc., New York, N. Y., first edition, 1954, 433 p., 10⅛ × 7⅞ in., bound. $11. Engineering data on metallurgical, physical, fabrication, and mechanical properties of over 500 typical metals are presented with comments characterizing each metal and indicating its uses. Intended as a convenient reference manual for the mechanical engineer and designer, the book is organized with metals grouped by kinds and individual metals listed in ascending numerical sequence by designations, usually those used by the fabricating industries. There is a separate cross-index to other systems of designation.

CAMS. DESIGN AND LAYOUT. By Louis Kasper. Chemical Publishing Company, Inc., New York, N. Y., 1954. 101 p., 8 × 5¼ in., bound. $3.50. A practical manual for engineers, designers, and draftsmen in which cumbersome, time-consuming, and unnecessary calculations have been avoided, while explanations sufficiently detailed for application have been stressed. Separate chapters cover general principles: reciprocating, rotating, cylindrical, sleeve, and other types of cams, miscellaneous applications, and some of the more important design factors and computations.

ELASTICITY, PLASTICITY, AND STRUCTURE OF MATTER. By R. Houwink. Harren Press, Washington, D. C., second edition, 1953. 368 p., 9½ × 6¼ in., bound. $7.50. A comprehensive study of the elastic and plastic phenomena which takes place upon the deformation of matter. Glass, resins, asphalt, textile fibers, natural and synthetic rubber, proteins, paints, clay, and sulphur are surveyed in order to compare and unify the observations on these materials and to provide an insight into the structure of matter. Crystalline substances are covered in a separate chapter by W. C. Burgers. A number of corrections and revisions have been made in this edition.

ENGINEERING ANALYSIS. By D. W. Ver Planck and B. R. Teare, Jr. John Wiley & Sons, Inc., New York, N. Y., 1954. 344 p., 9¼ × 6¼ in., bound. $6. An exposition for graduate and undergraduate students of professional methods for the solution of engineering problems. Most of the book is made up of cases, drawn from electrical, mechanical, and industrial-engineering fields, which illustrate how to define a problem, plan an approach, check results, and draw conclusions useful in dealing with future problems.

FESTIGKEITSLEHRE FÜR DEN LEICHTBAU. By E. Schapitz. Deutscher Ingenieur-Verlag, Düsseldorf, Germany, 1951. 259 p., 8⅜ × 6⅛ in., paper. 19 DM. Dealing with stress analysis in lightweight-metal construction, this book presents the most important theoretical considerations for the calculation of stiffened shells and solid-web systems, based on research in the field of metal-airplane design.

FORM IN ENGINEERING DESIGN. By J. Beresford-Evans. Oxford University Press, New York, N. Y., 1954. 96 p., 8⅛ × 5⅜ in., bound. $1.70. A study of techniques by

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which engineers and draftsmen can give a fine and lasting appearance to their products. Guiding principles, illustrated by examples of designs, are developed to show why certain shapes look better, how to treat large surfaces and details, how to handle difficult and ugly accessories, and how to select appropriate finishes.

FUEL TESTING. By Godfrey W. Himus. Leonard Hill, Ltd., London, England, third edition, 1953. 278 p., 10 × 6¼ in., bound. 25s. Methods of testing discussed are those of the British Standards Institution, the Fuel Research Board, and the Institute of Petroleum. While the major part of the book deals with the analysis of coal, there is some treatment of gas and liquid fuels. In this edition, there is new material on carbonaceous materials high in ash, and a new chapter on carbonization assays. The chapter on combustion calculations has been shortened.

HEAT CONDUCTION. By Leonard R. Ingersoll, Otto J. Zobel, and Alfred C. Ingersoll. University of Wisconsin Press, Madison, Wis., revised edition, 1954. 325 p., 9¼ × 6¼ in., bound. $5. The aims of the earlier editions—to provide an introduction to the subject for students, and to point out applications to engineers and geologists—are carried out further in the present edition. The principle changes are the addition of chapters on the theory of earth heat exchangers for the heat pump, and on drying and soil consolidation. The bibliography has been brought up to date.

HIGH-SPEED DIESEL ENGINES. By P. M. Heldt, Nyack, N. Y., seventh edition, 1953. 472 p. 8½ × 5½ in., bound. $7. In the present edition of this study covering theory, design, application, operation, and maintenance, the text has been completely revised with major additions made to chapters on injection pumps and governors, two-stroke engines, railroad engines, supercharging, methods of starting, and operation and maintenance. Chapters on aircraft and miscellaneous oil engines have been omitted.

INTRODUCTION TO ELLIPTIC FUNCTIONS. By F. Bowman. John Wiley & Sons, Inc., New York, N. Y., 1953. 115 p., 7½ × 5 in., bound. $2.50. A short, practical account of the Jacobian elliptic functions, intended for the engineer or physicist who wishes to familiarize himself with their properties. A few brief examples of applications to technical problems are given and practical guidance is provided on the use of available tables of these functions.

INTRODUCTION TO NUCLEAR ENGINEERING. By Raymond L. Murray. Prentice-Hall, Inc., New York, N. Y., 1954. 418 p., 8¾ × 6 in., bound. $9.35. Intended for the junior or senior engineering student, this textbook surveys the field of atomic energy and discusses some typical engineering problems. It deals with the nuclear reactor, nuclear fuels, handling radioactive materials, instruments for detection and control, and related subjects. In addition, there are chapters on the uses of isotopes, nuclear propulsion, and on electric power plants using nuclear fuel.

KONSTRUIEREN UND GESTALTEN. By Hans Tschochner. W. Girardet, Essen, Germany, 1954. 225 p., 8¼ × 6¼ in., bound. 14.80 DM. A treatment of machine-design theory based on a division of the over-all problem into two aspects: The creative process and its translation into terms of the total construction, installation, tools involved, etc.; and the development of the individual elements to provide optimum performance in the simplest manner at lowest cost.

LUBRICATION OF INDUSTRIAL AND MARINE MACHINERY. By William Gordon Forbes. Revised by C. L. Pope and W. T. Everitt. John Wiley & Sons, Inc., New York, N. Y., second edition, 1954. 351 p., 9¼ × 6¼ in., bound. $6.50. This is a practical manual integrating discussion of fundamental principles of lubricants with explanation of common mechanisms and their lubrication requirements. It covers the chemistry, refining, compounding, and specifications of lubricants; lubrication of such mechanisms as bearings, gears, pumps, etc.; and practical examples of the lubrication of equipment.

MACHINE TOOL OPERATION. By Henry D. Burghardt and Aaron Axelrod. McGraw-Hill Book Company, Inc., New York, N. Y. Part I: Fourth edition, 1953, 585 p., 8¼ × 5¾ in., bound. $4.25. Part II: Third edition, 1954, 677 p., 8¼ × 5¾ in., bound. $5. The first part of this text for apprentices and young machinists deals with safety, measuring tools, bench work, the drill press, the lathe, and forge work. The second part covers the principles of construction and operation of the shaper, planer, milling machine, grinders, and band saws. A number of chapters have been revised and some chapters added to include new tools, practices, and procedures.

MACRAE'S BLUE BOOK, 1954. MacRae's Blue Book Company, Chicago, Ill., sixty-first edition, 1954. 4132 p., 11 × 8½ in., bound. $15. This sixty-first annual edition, as in previous years, includes an alphabetical list of American industrial manufacturers and their distributors; a product listing, with manufacturers' addresses, of industrial equipment, materials, and products; and a trade-name section. Capital ratings are indicated where reliable information is supplied. A new feature of this edition is a duplicate alphabetical section printed separately to facilitate reference.

MATTHEWS' TEXTILE FIBERS. Edited by Herbert R. Mauersberger. John Wiley & Sons, Inc., New York, N. Y., sixth edition, 1954. 1283 p., 9¼ × 6¼ in., bound. $16.50. Comprehensive coverage by a staff of specialists of all natural, regenerated, and synthetic fibers, each dealt with separately, with citation of physical, microscopical, and chemical properties. The reactions of each fiber to organic and inorganic chemicals used in cleaning, bleaching, mercerizing, dyeing, etc., are presented in detail. The entire text has been brought up to date and much new information on man-made fibers has been added. A detailed index and chapter bibliographies are included.

MECHANICAL TESTING OF METALLIC MATERIALS. By R. A. Beaumont. Sir Isaac Pitman & Sons, Ltd., London, England, third edition, 1954. 250 p., 8¾ × 5¾ in., bound. 25s. Precise information is given on the carrying out of tensile, creep, hardness, impact, and other types of tests called for by British Standard Specifications. Descriptions of testing machines are included, with a separate chapter devoted to extensometers and recorders.

MOLECULAR THEORY OF GASES AND LIQUIDS. By Joseph O. Hirschfelder, Charles F. Curtiss and R. Byron Bird. John Wiley & Sons, Inc., New York, N. Y. 1954. 1219 p., 9¼ × 6 in., bound. $20. Part one surveys equilibrium statistical mechanics as the basis for theoretical development of the equation of state and discusses main applications of the theory. Part two covers nonequilibrium statistical mechanics, transport phenomena, and hydrodynamic applications. Part three deals with the electromagnetic and quantum mechanical theory of forces between molecules, atoms, ions, and free radicals. The book is intended for students in chemical physics and as a reference work for industrial engineers and others.

PROCEEDINGS OF A CONFERENCE ON THE UTILIZATION OF SCIENTIFIC AND PROFESSIONAL MANPOWER. National Manpower Council. Columbia University Press, New York, N. Y., 1954. 197 p., 9¼ × 6¼ in., bound. $3.50. This volume contains papers and discussion reports on the problem of the effective use of trained personnel, especially in engineering, medicine, and teaching. Aspects of the problem considered include the possible transfer of work to semiprofessionals, incentives to prevent turnover, reassessment of the education and training of professionals, improved administration and leadership, and others. Throughout the volume, present utilization policies are critically examined.

PROPERTIES OF GLASS. (American Chemical Society Monograph no. 124). By George W. Morey. Reinhold Publishing Corporation, New York, N. Y., second edition, 1954. 591 p., 9¼ × 6¼ in., bound. $16. A survey of all the measurable properties of glass and a review of the literature of the subject. In this revision the author has included all new measurements on glasses of known composition made since the first edition of 1938, new material on complex and commercial glasses, and new sections on the effect of heat-treatment and absorbed radiation on the properties of glass.

RELAXATION METHODS. By D. N. de G. Allen. McGraw-Hill Book Company, Inc., New York, N. Y., 1954. 257 p., 9¼ × 6¼ in., bound. $7.50. An introductory text for students or practicing engineers that takes up the process of solution in detail for various typical applications chiefly in the fields of elasticity, hydrodynamics, electricity, and magnetism. Emphasis is placed on the essential arithmetical processes and techniques. Mathematical theory is kept to a minimum.

1953 SUPPLEMENT TO BOOK OF ASTM STANDARDS, INCLUDING TENTATIVES. Part 1. Ferrous metals, 363 p.; 2, nonferrous metals, 278 p., 3, cement, concrete, ceramics, thermal insulation, road materials, waterproofing, soils, 383 p.; 4, paint, naval stores, wood, fire tests, sandwich construction, wax polishes, 161 p.; 5, fuels, petroleum, aromatic hydrocarbons, engine antifreezes, 332 p.; 6, rubber, plastics, electrical insulation, 193 p.; 7, textiles, soap, water, paper, adhesives, shipping containers. American Society for Testing Materials, Philadelphia, Pa., 1954. 9 × 6 in., paper. $3.50 each. These supplements, one for each of the seven parts of the 1952 book of American Society for Testing Materials Standards, give in their latest form 325 specifications, tests, and definitions first issued in 1953 or revised since the publication of the 1952 standards.

SYMPOSIUM ON NON-DESTRUCTIVE TESTING. (Special Technical Publication, no. 145.) American Society for Testing Materials, Philadelphia, Pa., 1953. 98 p., 9 × 6 in., paper, $2. Eight papers on advanced methods and techniques used in a number of countries for solving specific testing problems. Subjects discussed include weld radiography; the use of iridium 192 in fluoroscopy and radiography, and electronic sorting of

metals for physical properties. There are also several papers on ultrasonic methods and applications. Although attention is centered on the testing of metals, the data and ideas presented are applicable to the testing of other materials.

SYNCHRONOUS INDUCTION MOTOR. By J. Griffin. Macdonald & Company, Ltd., London, England, 1954. 136 p., $8^3/_4 \times 5^3/_4$ in., bound. 18s. An over-all review of present-day practice for designers and users. The book opens with chapters on starting, synchronizing, and the elementary theory of this type of motor. Theoretical and operational aspects of such subjects as power-factor correction, overload capacity, braking, etc. are then discussed. A separate chapter is devoted to the salient-pole motor, and there is a chapter on mechanical construction. A bibliography of thirty-three references is included.

TABLES OF INTEGRAL TRANSFORMS. Volume I. Compiled by the staff of the Bateman Manuscript Project, California Institute of Technology. McGraw-Hill Book Company, Inc., New York, N. Y., 1954. 391 p., $9^3/_8 \times 6^1/_4$ in., bound. $7.50. The first of two volumes giving tables of integrals involving higher transcendental functions, designed for the use of mathematicians, scientists, and engineers. It covers Fourier transforms (sine, cosine, and exponential), Laplace transforms and inverse Laplace transforms, Mellin transforms and inverse Mellin transforms. Each transform has a separate chapter proceeding from general formulas through tabulations of functions of increasing complexity.

TITANIUM AND ITS COMPOUNDS. By Gordon Skinner, Herrick L. Johnston and Charles Beckett. Herrick L. Johnston Enterprises, Columbus, Ohio, 1954. 174 p., $10^3/_4 \times 7^1/_4$ in., bound. $5. Most of the pertinent literature through 1951 is surveyed for data on the preparation and properties of titanium, its hydrides, oxides, halides, nitride and carbide, and the alkaline earth titanates. All the properties of each of the substances are discussed under the specific substance except for the thermodynamic properties which are tabulated in the appendixes. There is a bibliography of 553 references.

TITANIUM AND TITANIUM ALLOYS. By John L. Everhart. Reinhold Publishing Corporation, New York, N. Y., 1954. 184 p., $6^3/_4 \times 4^1/_4$ in., bound. $3. A survey of titanium as a commercial material, this book is intended for the engineer or designer interested in using the metal in the solution of his problems. Production and properties are briefly considered as background for a summary of recent technology, including heat-treatment, forming and fabricating, joining, machining and grinding, and cleaning and finishing. Chapter references are included.

WASSERAUFBEREITUNG IM DAMPFKRAFTBETRIEB. By A. Splittgerber. Springer-Verlag, Berlin, Germany, 1954. 430 p., 10×7 in., bound. 48 DM. A handbook on water treatment in steam power plants. The main sections deal with the principles of water chemistry; water for stationary, marine, and locomotive boilers; protection of boilers and boiler equipment; and water treatment for water supply, heating, and condenser installations. It also deals with costs and regulations, and a 1700-item bibliography is included.

ZAHNFORMEN DER ZAHNRADER. By Hermann Trier. Springer-Verlag, Berlin, Germany, fourth edition, 1954. 73 p., $9 \times 6^1/_8$ in., paper. 3.60 DM. A concise presentation of the fundamentals of the development of gear-tooth profiles. There are separate chapters on straight-tooth spur gears, helical spur gears, bevel gears, and worm gears. Examples of calculations are given throughout.

ZERSTÖRUNGSFREIE WERKSTOFFPRÜFUNG. Edited by the Institut für Metallforschung, Saarbrücken, and others. Verlag Stahleisen, Düsseldorf, Germany, 1952. 166 p., $10^5/_8 \times 8^1/_4$ in., paper. 17.60 DM. A compilation of twenty papers dealing with nondestructive testing methods mainly radiographic or ultrasonic, but also including spectrographic, magnetic, electronic, and oil-powder methods. Some specialized applications are described as a dynamic method for determining elastic constants and the checking of the thickness of a rolled material during processing. In French or German only.

ASME BOILER CODE

Interpretations

THE Boiler Code Committee meets monthly to consider "Cases" where users have found difficulty in interpreting the Code. These pass through the following procedure: (1) Inquiries are submitted by letter to the Secretary of the Boiler Code Committee, ASME, 29 West 39th Street, New York 18, N. Y.; (2) Copies are distributed to Committee members for study; (3) At the next Committee meeting interpretations are formulated to be submitted to the ASME Board on Codes and Standards, authorized by the Council of the Society to pass upon them; (4) They are submitted to the Board for action; (5) Those which are approved are sent to the inquirers and are published in MECHANICAL ENGINEERING.

(The following Case Interpretations were formulated at the Committee meeting June 11, 1954, and approved by the Board on July 30, 1954.)

CASE NO. 1119-2 (REOPENED)

(Special Ruling)

Inquiry: May austenitic chromium-nickel alloy steels which are stabilized with columbium plus tantalum be used under Code rules which are applicable to the use of stainless steel Types 309Cb, 316Cb, and 347?

Reply: It is the opinion of the Committee that austenitic chromium-nickel alloy steels which are stabilized with columbium plus tantalum instead of columbium only may be used under the Code rules which are applicable to the use of Types 309Cb, 316Cb, and 347, with the following restrictions.

(1) *Material*—The material shall conform to an approved specification and grade covering Types 309, 316, or 347 modified by additions of columbium, except that the requirements for columbium contents shall be modified as follows:

Columbium: determination not required.
Columbium plus tantalum: 1.25 per cent, max; $8 \times$ the carbon content, min.

(2) These steels, stabilized with columbium alone, may be used with a minimum columbium content of $8 \times$ the carbon content.

(3) Working stresses shall be the same as those listed for the standard grades stabilized with columbium alone.

CASE NO. 1122-3 (REOPENED)

(Special Ruling)

Inquiry: May the extra-low-carbon grades of the austenitic stainless steels Types 304, 316, and 317 be used under the applicable Code rules pertaining to the regular grades of austenitic stainless steels?

Reply: It is the opinion of the Committee that the extra-low-carbon grades of Types 304, 316, and 317 may be used for construction under the Code rules applying to the regular grades of Types 304, 316, and 317 with the following modifications:

(1) The material shall conform to the requirements of an approved specification which covers the same grade with regular carbon content, except that:

(a) The carbon content shall be limited to 0.03 per cent max.

(b) The mechanical properties shall be as follows:

Tensile strength	70,000 psi min
Yield strength	25,000 psi min
Elongation in 2 in.	—as required by specification

(c) The stress values in tension (see table below) are to be used for vessels under internal pressure.

(2) The extra-low-carbon grades of austenitic steels Types 304, 316, and 317 may be used for the construction of vessels under external pressure under the Code rules applying to the regular grades of Types 304, 316, and 317.

(a) The material shall conform to paragraphs (1)(a) and (b) above.

(b) The required thickness of shells and heads, and the required moment of inertia for stiffening rings, shall be determined from the chart in Fig. UHA-28.3 for Type 304L, and from the chart in Fig. UHA-28.4 for Types 316L and 317L.

operate at temperatures between minus 20 F and 150 F and at a maximum stress value of one fourth of the minimum specified tensile strength and that the vessels may be stamped with the Code symbol provided the following requirements are complied with:

(1) The material is made by the open-hearth or electric-furnace process.

STRESS VALUES FOR CASE NO. 1122-3

Alloy Material (L)	Spec Min Tensile	—20 to 100	200	300	400	500	600	650	700	750	800
Type 304 (T.S.)*	70000	17500	17000	16000	15000	14000	13000	12500	12000	11500	11000
Type 304 (Y.S.)	70000	17500	17000	13400	11000	9700	9000	8750	8500	8300	8100
Type 316 (T.S.)*	70000	17500	17500	15800	14750	14000	13600	13450	13250	13000	12700
Type 316 (Y.S.)	70000	17500	17500	14500	12000	11000	10150	9800	9450	9100	8800
Type 317 (T.S.)*	70000	17500	17500	15800	14750	14000	13600	13450	13250	13000	12700
Type 317 (Y.S.)	70000	17500	17500	14500	12000	11000	10150	9800	9450	9100	8800

* At temperatures from 200 F through 800 F these stress values meet all of the criteria specified for establishing stress values except that they exceed 62½ per cent but do not exceed 90 per cent of the yield strength at temperature. They may be used where slightly greater deformation is permissible.

(NOTE: Figs. UHA-28.3 and UHA-28.4 will be included in the published Case Interpretations and are also available from the Secretary of the Boiler Code Committee, ASME, 29 West 39th St., New York 18, N. Y.)

CASE NO. 1134-1 (REOPENED)

(Special Ruling)

Inquiry: May seamless steel pipe or tubing conforming to the following chemical analysis (including check analysis) and having minimum specified tensile strength, yield strength, and elongation shown below be used in the construction of special integrally forged unfired pressure vessels?

	PER CENT	
Carbon	0.25-0.50	
Manganese	0.35-0.90	
Phosphorus	0.05 max	
Sulphur	0.05 max	
Silicon	0.15-0.40	
Chromium	0.74-1.16	
Molybdenum	0.12-0.25	
Minimum Specified Tensile Strength	120,000 psi	100,000 psi
Minimum Specified Elongation in 2"	18%	22%
Minimum Specified Yield Strength	74,000 psi	70,000 psi

Reply: It is the opinion of the committee that these materials may be used for the construction of seamless vessels to

(2) There are no stress raisers, such as openings, welded attachments, or stampings, on the shell portion.

(3) The maximum inside diameter of the shell is 24 in. and the maximum volume of the vessel is 5 cu ft.

(4) The integral heads are hot formed, concave to the pressure, and so shaped and thickened as to provide details of design and construction of the center opening which will be as safe as those provided by the rules of the Code. The center openings shall not exceed 50 per cent of the outside diameter of the vessel or 3 inch pipe size. Other openings in the head shall not exceed ¾ in. pipe size and shall be placed at a point where the calculated stress, without holes, is not more than one half the maximum allowable stress value.

(5) No welding is utilized.

(6) After all forming operations, vessels are heated to a temperature above the upper critical temperature, but in no case exceeding 1700 F, quenched in oil and then tempered at not less than 1100 F for one hour per inch of thickness but in no case less than one hour.

(7)(a) For batch furnace treatment, one tensile specimen is tested from a ring of material heat-treated with each furnace batch or from one of the vessels constituting the batch. If the batch exceeds 200, one tensile specimen shall be tested from each lot of 200 or less.

(b) For continuous furnace treatment, one tensile specimen is tested from a ring of the material heat-treated with each lot of 200 or less or from a vessel from each lot of 200 or less. In no case may one tensile specimen represent more than four hours furnace production.

(c) Rings for tensile specimens or vessels from which tensile specimens are cut are from one of the melting furnace heats of steel in the vessel being treated and each melting furnace heat of steel is represented by at least one test.

(d) Recording temperature devices are used and records are made available to the inspector.

(8) The material of the vessel is not subject to corrosion on the interior or exterior.

(9) The vessels comply with all other requirements of Section VIII, 1950 Edition, including requirements for pressure relief devices.

Typical sections of special seamless vessels are shown in the sketch.

(NOTE: The sketch referred to will be included in the published Case Interpretations and is also available from the Secretary of the Boiler Code Committee, ASME, 29 West 39th St., New York 18, N. Y.)

CASE NO. 1167-1 (REOPENED)

(Special Ruling)

Add the following paragraph as a last paragraph to the Reply published in the September, 1953, MECHANICAL ENGINEERING.

A further consideration of available data indicates that a stress value of 11,700 psi is satisfactory for operation at temperatures up to and including 250 F.

CASE NO. 1174-1 (REOPENED)

(Special Ruling)

Inquiry: Will unfired pressure vessels fabricated by fusion welding under the applicable rules of Section VIII, 1952 Edition, meet the intent of the Code if the base material is an aluminum-magnesium-chromium alloy having the following composition (Alloy GR40A Specification SB-178):

	PER CENT
Magnesium	3.1 to 3.9
Chromium	0.15 to 0.35
Copper	0.10 max
Manganese	0.10 max
Zinc	0.20 max
Iron plus silicon	0.45 max
Other, each	0.05 max
Other, total	0.15 max
Aluminum	remainder

Reply: It is the opinion of the Committee that the aluminum-magnesium-chromium alloy described in the Inquiry may be used for the construction of unfired pressure vessels according to the applicable rules of Section VIII, 1952 Edition, subject to the following conditions:

(1) The mechanical properties of the material are not less than the following:

Condition	Tensile strength, psi	Yield strength, psi (0.2 per cent offset)	Elongation in 2 in., per cent
Annealed	30000	11000	18
H112	30000	11000	8
H32	36000	26000	8
H34	39000	29000	6

(2) Sheet and plate further meet the applicable requirements of Specification SB-178.

(3) Rod, bar, and shapes further meet the applicable requirements of Specification SB-273.

(4) Pipe and tube further meet the applicable requirements of Specification SB-274.

(5) Fabrication is by fusion welding using filler metal complying in composition with the base material.

(6) The welding requirements and applicable paragraphs of Section IX, 1953 Edition, apply except that the tensile strength of the reduced-section tensile specimens shall be not less than 30,000 psi.

(7) The following maximum allowable stress values are used in applying the design rules where reference is made to Table UNF-23:

Condition	Metal temperature not exceeding deg F: 100	150	200	250	300	350	400
Annealed, H112	7350	7350	7350	7000	6400	5650	4900
H32	9000	8950	8850	8250	7400	6500	5600
H34	9750	9700	9500	8800	7900	6900	5900

(8) For welded joints, the allowable stress values for annealed material are used.

(9) In view of the fact that this alloy does not undergo a marked drop in impact resistance at low temperatures, no additional requirements are specified for temperatures down to —325 F (see Par. UNF-65).

(10) The joint efficiency factors, inspection, and testing comply with the applicable paragraphs of Section VIII, 1952 Edition.

(11) Thermal stress-relieving is not mandatory.

(12) Bolting materials conform to an aluminum alloy listed in Table UNF-23 or of one of the grades of austenitic steel of Specification SA-193. These bolting materials shall not be welded. The allowable stress values in Table UNF-23 or UHA-23 shall apply.

(13) In addition to the material described herein, any of the aluminum alloy materials for which allowable stress values for welded construction are given in Table UNF-23 may be used for appurtenances and other attachments. These parts and their connections shall be designed in accordance with the lower of the stress values in Par. (7) above and the applicable values in Table UNF-23. The welding process for these connections shall be qualified in accordance with the applicable rules of Section IX, 1953 Edition, except that the strength of the reduced-section tensile specimen shall be not less than the lower of the specified tensile strength of the two materials in the annealed temper.

(14) Cylindrical and spherical shells for external pressure and formed heads convex to pressure shall be designed by the rules of Pars. UG-28 and UG-33, respectively, using Fig. UNF-28.13.

(NOTE: Fig. UNF-28.13 will be included in the published Case Interpretations and is also available from the Secretary of the Boiler Code Committee, ASME, 29 West 39th St., New York 18, N. Y.)

CASE No. 1188

(*Special Ruling*)

Inquiry: Is it permissible in welded construction conforming to the requirements of Section VIII to use plates, pipes, tubes, and forgings which meet the following chemical and physical requirements:

Carbon, per cent	0.07 max
Manganese, per cent	2.00
Phosphorus, per cent	0.035 max
Sulphur, per cent	0.035 max
Silicon, per cent	1.00 max
Chromium, per cent	19.00 –21.00
Nickel, per cent	24.00 –30.00
Molybdenum, per cent	2.00 – 3.00
Copper, per cent	3.00 – 4.00
Columbium plus tantalum, min, per cent	8 × C
max, per cent	1.00
Tensile strength, psi	75,000 min
Yield strength, psi	30,000 min
Elongation in 2 in., per cent	30 min

Reply: It is the opinion of the Committee that the materials specified in the Inquiry may be used in the construction of welded pressure vessels under the rules of Section VIII provided the following additional requirements are complied with:

(1) The various product-forms shall meet all the requirements of the following specifications except that the chemical and physical requirements shall be those specified in the Inquiry.

SA-240 Corrosion-Resisting Chromium and Chromium-Nickel Steel Plate, Sheet, and Strip for Fusion-Welded Unfired Pressure Vessels

SA-312 Seamless and Welded Austenitic Stainless Steel Pipe

SA-249 Welded Austenitic Stainless Steel Boiler, Super-Heater, Heat Exchanger, and Condenser Tubes

SA-182 Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service

(2) The maximum allowable stress values shall be those given in Table I of this Case.

(3) The special design, fabrication, and inspection requirements given in Part UHA for Type 304 austenitic stainless steel shall apply to this material.

(4) The material shall be subject to the same requirements in Section IX as for Type 304 austenitic stainless steel.

(5) The thickness of material used shall not exceed $1\frac{1}{2}$ in. A separate welding procedure qualification shall be made for each thickness from each heat of material that exceeds $\frac{3}{4}$ in. in thickness.

(6) All longitudinal and circumferential joints shall be of the double-welded butt type or its equivalent.

(7) All butt-welded main joints shall be fully radiographed when the thickness at the welded joint exceeds $\frac{3}{8}$ in.

(8) All welds used throughout the

TABLE I FOR CASE NO. 1188 MAXIMUM ALLOWABLE STRESS VALUES IN POUNDS PER SQUARE INCH

Metal temperatures not exceeding deg F: 100	200	300	400	500	600	650	700	750	800
18750	18750	17900	17500	17200	17100	17050	17000	16900	16750

vessel shall be examined by the fluid-penetrant method.

(9) For qualifying the welding procedure the material shall be included under P-Number 8 of Table Q-11.1 and A-Number 8 of Table Q-11.3 of Section IX.

CAUTIONARY NOTE: In publishing these specifications, The American Society of Mechanical Engineers disclaims responsibility for infringement of any letters patent by the user of such specifications; and such publication is not to be construed as a representation that the specifications may be used or applied without the permission of the owner of any patent involved therein or as a recommendation of any patented material which may be covered by the specifications.

CASE No. 1189

(Special Ruling)

Inquiry: Will flanged connections be considered to comply with Pars. H-31 and H-88 if they are designed with diameter and bolting according to Tables A-5 to A-8 (Appendix to Section I) and with other dimensions calculated according to the rules in Appendix II of Section VIII?

Reply: It is the opinion of the Committee that steel flanged connections designed with diameter and bolting according to Tables A-5 to A-8 and with other dimensions calculated according to the rules of Appendix II, Section VIII, will comply with the intent of the Heating Boiler Code.

CASE No. 1190

(Special Ruling)

Inquiry: Will the use in pressure vessels of bronze castings conforming to ASTM Specification B143-52 meet the intent of Section VIII of the Code?

Reply: It is the opinion of the Committee that the use of castings conforming to ASTM Specification B143-52 will meet the intent of Section VIII of the Code, provided no welding of this material is involved.

The maximum allowable design stresses given in Table UNF-23 for SB-61 will apply.

CASE No. 1191

(Special Ruling)

Inquiry: When alpha aluminum bronze alloy plates, sheets, pipes, tubes, and shapes conforming to an approved specification are used for the construction of vessels to be used for external pressure, under what rules shall they be designed and fabricated?

Reply: It is the opinion of the Committee that alpha aluminum bronze alloy plates, sheets, pipes, tubes, and shapes that conform to an approved specification may be used for the construction of external pressure vessels and the vessels may be stamped with the Code symbol providing the following requirements are complied with:

(1) The applicable rules in the 1952 edition of Section VIII of the Code covering vessels under external pressure when constructed of nonferrous materials shall be adhered to.

(2) The thickness of shells and heads and the required moment of inertia for stiffening rings shall be determined from the charts in Fig. UNF-28.14 for alpha aluminum bronze and in Par. UNF-30.

(NOTE: Fig. UNF-28.14 will be included in the published Case Interpretations and is also available from the Secretary of the Boiler Code Committee, ASME, 29 West 39th St., New York 18, N. Y.)

Annulment of Cases

CASE NO.	REASON FOR ANNULMENT
1053	Seamless tubing is readily available
1074	External-pressure vessel charts are now available
879, 1022, 1165, 1176	The provisions of these Cases are now included in the 1953 edition of Section IX, Welding Qualifications
1146, 1150	These two Cases are no longer emergency alternate provisions
1136	Government restriction on molybdenum has now been cancelled
1158	The provisions of this Case are included in Section II, 1952 Edition

Proposed Revisions and Addenda to Boiler and Pressure Vessel Code...

AS NEED arises, the Boiler Code Committee entertains suggestions for revising its Codes. Revisions approved by the Committee are published here as proposed addenda to the Code to invite criticism. If and as finally approved by the ASME Board on Codes and Standards, and formally adopted by the Council, they are printed in the annual addenda supplements to the Code. Triennially the addenda are incorporated into a new edition of the Code.

In the following the paragraph numbers indicate where the proposed revisions would apply in the various sections of the Code.

Comments should be addressed to the Secretary of the Boiler Code Committee, ASME, 29 West 39th Street, New York 18, N. Y.

Power Boilers, 1952

PAR. P-11 Add the following specification reference to the end of the paragraph:

SA-369 Ferritic Alloy Steel Forged and Bored Pipe for High-Temperature Service

PAR. P-111 Add as a third sentence: "Furnaces shall be rolled to practically a true circle with a maximum permissible deviation from the true circle of not more than $^1/_4$ inch."

PAR. P-242 Renumber present Par. P-242 as Par. P-242(a), and add a new subparagraph as (b).

NOTE: The length of Par. P-242(b) prohibits its publication in MECHANICAL ENGINEERING. Copies are available from the Secretary of the Boiler Code Committee, ASME, 29 West 39th St., New York 18, N. Y.

Material Specifications, 1952

An errata sheet to Material Specifications, Section II, 1952 Edition, editorially revising specifications affected, is available from the Secretary of the Boiler Code Committee, ASME, 29 West 39th St., New York 18, N. Y.

Heating Boilers, 1952

PARS. H-31 AND H-88 Revise both paragraphs to read:

It is recommended that dimensional requirements of bolted flange connections to external piping conform to: Steel Pipe Flanges and Flanged Fittings ASA B16.5-1953. Such flanges may be used for pressure-temperature ratings in accordance with the Standard.

Steel flanges may also be designed in accordance with the rules in Appendix II of Section VIII for the design pressure and temperature conditions. The outside diameter and bolting shall conform to a standard approved by ASA.

Unfired Pressure Vessels, 1952

PAR. U-1(d)(2) Revise the change published in March, 1954, MECHANICAL ENGINEERING, to read:

(2) Vessels with a nominal water-containing capacity of 120 gallons or less for containing water under pressure, including those containing air, the compression of which serves only as a cushion.

PAR. U-1(d)(3) Delete the word "domestic" from the revision published in March, 1954, MECHANICAL ENGINEERING.

PARS. UA-601(b) AND UA-602(b) Revise both paragraphs to read:

(1) $^1/_5$ of the tensile strength as adjusted to minimum; and

(2) $^1/_4$ of the yield strength (as defined in the material specifications) as adjusted to minimum.

ASME NEWS

With Notes on the Engineering Profession

Currently heading Engineers Joint Council are, *left to right*, Thorndike Saville, president; C. S. Proctor, vice-president; E. L. Chandler, treasurer; and S. E. Reimel, secretary. EJC is made up of eight major engineering organizations, which include ASCE, AIME, ASME, AWWA, AIEE, SNAME, ASEE, and AIChE, with an individual membership of 170,000.

EJC Amends Constitution to Broaden Participation in the Profession's Policies and Activities Provision Made for Local Units

- **1955 Nuclear Engineering Convocation Contemplated**
- **World Power Conference Announces Plans for Future**

In a major action to increase the unity of the engineering profession, Engineers Joint Council has adopted two important constitutional amendments permitting, under prescribed conditions, the admission of national and local organizations not presently meeting all the qualifications for constituent membership. Conditions for admission are being drafted by a special committee.

EJC at present is constituted of eight major engineering organizations with a total individual membership of 170,000. These are the American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, American Water Works Association, American Institute of Electrical Engineers, Society of Naval Architects and Marine Engineers, American Society for Engineering Education, and American Institute of Chemical Engineers.

Amendments Effective July 8

The amendments were made effective by the Executive Committee on July 8, following affirmative action by each of the constituent societies. A total membership of at least 5000 is required of a national organization to qualify as a constituent society. The first amendment permits the admission, as Associates, of national organizations with less than 5000 members.

The second amendment permits the admission, as Affiliates, of societies "which are regional rather than national in geographical scope." This amendment also permits the admission, as Affiliates, of "federations of engineering societies (or of sections of such societies) broadly representative of the engineering profession in cases in which the majority of the societies who are members of the federation have qualifications for voting members equivalent to those required of constituent societies of the Council."

In both instances, Associates and Affiliates, the one relating to national organizations and the other to local or regional organizations, admission would be without official vote. Nonetheless, provision is made for representatives to participate in the Council's meetings.

The two new amendments open the way for extending the scope of the Council to organizations which have important roles in the engineering profession but which could not, presently, qualify under all conditions for constituent membership.

The steps taken to adopt the amendments were a consequence of suggestions made in 1951 by the Exploratory Group that had been named to consider the increased unity of the engineering profession and came forward with a number of proposals. One result of the early action of the Exploratory Group was the admission of the American Water Works Association, the Society of Naval Architects and Marine Engineers, and the American Society for Engineering Education as constituent societies of EJC.

EJC Objectives

The purposes of prospective Associates or Affiliates, under the new amendments, are within the scope of the objectives of the Council. These include the advancement of the general welfare of mankind through the available resources and creative ability of the engineering profession; co-operation of the branches of the profession; advancement of the science and profession of engineering; development of sound public policies in national and international affairs wherein the profession can be helpful through the services of members of the profession.

The Council, to achieve these objectives, acts as an advisory and co-ordinating agency to seek and study matters of mutual interest to the constituent societies and to recommend parallel action by them; represents the constituent societies in instances in which these societies desire such joint representation; administers, on behalf of the engineering profession, activities authorized by a majority of the constituent societies.

The officers of Engineers Joint Council are: President, Thorndike Saville; Vice-President, Carlton S. Proctor; Treasurer, E. Lawrence Chandler; Secretary, Stewart E. Reimel.

EJC Organizes Nuclear-Engineering Group

To meet "the pressing problems of nuclear engineering and the related sciences," with particular interest in "industrial usefulness," EJC announced initial steps toward an organized program of confronting these problems "authoritatively by a group of leading engineers."

In making the announcement, Thorndike Saville, president of the Council and dean of engineering at New York University, commented that "action by this powerful engineering group is further evidence that nuclear energy is well on the way to having important peacetime industrial usefulness."

An early invitation will be extended to the societies of physicists and chemists to join the engineers in planning a strong organization, it was reported by Warren L. McCabe, administrative dean at The Polytechnic Institute of Brooklyn, chairman of EJC Committee on Recognition of Specialties in Engineering. The movement is expected to bring together most of the country's eminent participants in industrial nuclear development.

National Convocation in 1955

Although organization of the new group is in its initial stages, a national convocation in 1955 is contemplated for discussion of the subject of nuclear development for industrial use.

The announcement was as follows:

"The pressing problems of nuclear engineering and the related sciences are to be dealt with authoritatively by a group of leading engineers.

"In this announcement, Thorndike Saville, EJC president, is joined by Daniel V. Terrell, ASCE president; Leo F. Reinartz, AIME president; Lewis K. Sillcox, ASME president; Alexander C. Monteith, AIEE president; Chalmer G. Kirkbride, AIChE president; Dale L. Maffitt, AWWA president; William E. Blewett, Jr., SNAME president; and Nathan W. Dougherty, ASEE president. Under the general policy of EJC to encourage the close co-operation of specialists in engineering, a strong joint agency will be set up to organize the co-operation of all engineering groups and related scientists to develop discussions of nuclear engineering subjects and to deal with the publication of worth-while papers and addresses.

"Action by this powerful engineering group is further evidence that nuclear energy is well on the way to having important peacetime industrial usefulness."

As to the likelihood of an invitation to others to join the engineers' program, Dean McCabe said: "We agree as to the desirability of bringing in the physicists, chemists, and perhaps other related groups, but at the moment our responsibility is largely in the engineering field."

World Power Conference

Word has come from Rio de Janeiro that the International Executive Council, World Power Conference, has designated Vienna and June 16–25, 1956, for the Fifth World Conference. A Brazil Section meeting was held July 25–Aug. 10. The Conference is composed of organizations in the power field throughout the free world.

Other dates on the schedule were announced as follows: International Executive Committee, Paris, May 31, 1955; Section meeting, Jugoslavia, 1957; Section meeting, Canada, 1958; Section meeting, Switzerland, 1960; Sixth World Power Conference, 1962, country to be designated.

The Rio sessions drew 526 registrants, of whom 313 were from 32 countries other than Brazil. A total of 94 technical papers were presented. Paraguay and Thailand were elected members. Spain was readmitted.

ASME-IRD Program at ISA Congress Announced

The first International Instrument Congress and Exposition at the Commercial Museum and Convention Hall, in Philadelphia, Pa., Sept. 13 to 24, will offer the largest number of technical sessions on instrumentation, and will present the largest assembly of instruments and devices for measurement, inspection, testing, and control, ever gathered in one place.

The complete exhibit represents 70,000 sq ft, which will be used by 450 domestic and foreign exhibitors.

Many instruments are being shown for the first time, and the executives and top scientists and engineers of the exhibitors will be on hand to discuss and explain many new applications of their products.

Twelve societies, including the Instruments and Regulators Division of The American Society of Mechanical Engineers, co-operated with the Instrument Society of America in the preparation of the technical program.

The ASME program follows:

Wednesday, September 15

9:30 a.m. Session 1

International Symposium on Terminology—Foreign Contributors

Process Control Terminology, by *A. J. Young*, Imperial Chemical Industries, Ltd., Millbank, London, England

The Standardization of Automatic Control Terminology in Germany, by *Rudolph Oetker*, Siemens & Halske, A. G., Karlsruheknielingen, Germany

2:30 p.m. Session 2

International Symposium on Terminology—Domestic Contributors

Integration of Concepts in the Terminology of Measurement and Control, by *H. L. Mason*, Office of Basic Instrumentation, National Bureau of Standards, Washington, D. C.

Terminology Applied to Automatic Control Combinations, by *Lowell Ledgett*, Colgate-Palmolive Co., Jersey City, N. J.

Group leaving from Idlewild International Airport, New York, N. Y., for Brazil where conventions were held by World Power Conference, Inter-American Association of Sanitary Engineering, and UPADI. Shown, *left to right,* are: Brig. Gen. Stewart E. Reimel (ret.), ASCE, ASME, Secretary, Engineers Joint Council; Walter G. Whitman, AIChE, chairman, Reactor Subcommittee, General Advisory Committee, AEC; Alex D. Bailey, Fellow, Hon. Mem., and Past-President, ASME, and member, ASEE; Wilbur A. Dexheimer, ASCE, Commissioner, Bureau of Reclamation, and Mrs. Dexheimer; Eugene W. Weber, ASCE, International Joint Commission; and Gail A. Hathaway, Past-President, ASCE, President, International Commission on Large Dams, World Power Conference. (*Pan American World Airways Photo.*)

8:00 p.m. Session 3

Panel Discussion on Terminology

Panel Members to be announced.

Thursday, September 16

9:30 a.m. Session 4

International Symposium on Education—Foreign Contributors

The Education and Training of Professional Engineers in the United Kingdom, by *Willis Jackson*, Metr-Vickers Electric Co., Ltd., Trafford Park, Manchester, England

Servo Teaching in France, With Special Reference to Aeronautical Engineers, by *J. Charles Gille*, École Superieure de l'Aeronautique, Paris, France

2:30 p.m. Session 5

International Symposium on Education—Domestic Contributors

The Education of the Professional Engineer, by *L. M. K. Boelter*, University of California, Los Angeles, Calif.

The Role of Measurement and Control in Engineering Education, by *J. A. Hrones*, Massachusetts Institute of Technology, Cambridge, Mass.

The Organization of Instrumentation Programs Within Universities, by *R. J. Jeffries*, Michigan State College, East Lansing, Mich.

Friday, September 17

9:30 a.m. Session 6

Symposium on Ten Years of Progress in Instrumentation

Title to be announced, by *Ralph D. Webb*, Carbide and Carbon Chemicals Co., Charleston, W. Va.

Title to be announced, by *H. C. Frost*, Corn Products Refining Co., Chicago, Ill.

Title to be announced, by *J. W. Percy*, United States Steel Corp., Kearny, N. J.

New Advances in Servo Type Systems, by *Messrs. Kinard, MacIntoch, and Hanson*, General Electric Co., West Lynn, Mass.

2:30 p.m. Session 7

Panel Discussion: The Economics of Instrumentation

Panel Members: *Harry F. Moore*, Standard Oil Development Co., Linden, N. J.; *H. C. Frost*, Corn Products Refining Co., Chicago, Ill.; *F. P. Fairchild* and *V. S. Renton*, Public Service Electric & Gas Co., Newark, N. J.; *A. G. Woodside*, General Electric Co., Schenectady, N. Y.; *E. I. Thomas*, Carbide and Carbon Chemicals Co., South Charleston, W. Va.; and *Albert F. Sperry*, Panellit, Inc., Chicago, Ill.

1954 ASME West Coast Applied Mechanics Conference

West Coast Applied Mechanics Division Conference of The American Society of Mechanical Engineers was held at the Berkeley Campus of the University of California, June 21–23. Co-operating with the Conference this year was the Applied Mechanics West Coast Division of the American Society of Civil Engineers, who sponsored one session on structures. A total of 16 papers were presented under the headings of vibrations, structures, elasticity and shells, properties of materials, nonlinear mechanics, and dynamics.

Aside from the technical sessions, the group gathered for a dinner at the Faculty Club where Prof. T. C. Blaisdell of the political science department and director of bureau of international relations, spoke on the current international situation. Of considerable interest to the group was the conducted tour through the U. C. Radiation Laboratory. Dr. Hayden Gorden of the laboratory gave a short talk on the several different types of nuclear machines which were inspected.

At the business meeting of the West Coast Committee, the date for the 1955 Conference was established for the second week in September. The West Coast Committee for 1955 consists of R. M. Hermes, D. S. Wood, J. Alford, W. W. Soroka, secretary; W. T. Thomson, chairman. Further information regarding the 1955 Conference will be published within a few months.

Availability List for 1954 ASME West Coast Applied Mechanics Conference Papers

The papers in this list are available in separate copy form until April 1, 1955. Please order only by paper *number;* otherwise the order will be returned. Copies of these papers may be purchased from the ASME Order Department, 29 West 39th Street, New York 18, N. Y.

Paper No.	*Title and Author*
54—APM-2	Polyaxial Stress-Strain Relations of a Strain-Hardening Metal, by S. B. Batdorf and Bernard Budiansky
54—APM-3	Prediction and Evaluation of Sensitivity to Transient Accelerations, by M. Kornhauser
54—APM-4	Boundary-Value Problems of the Thin-Walled Circular Cylinder, by N. J. Hoff
54—APM-5	Impulsive Response of Beams in the Elastic and Plastic Regions, by W. T. Thomson
54—APM-6	Vibration of Triangular Cantilever Plates by the Ritz Method, by B. W. Andersen
54—APM-7	The Anticlastic Curvature of a Strip With Lateral Thickness Variation, by Y. C. Fung and W. H. Wittrick
54—APM-8	Steady-State Vibrations of Beam on Elastic Foundation for Moving Load, by J. T. Kenney, Jr.
54—APM-9	A Simple Nomogram for the Ratios of Octahedral to Maximum Shearing Stresses and Its Physical Interpretation, by G. A. Zizicas

ASME Membership as of July 31, 1954

Honorary Members	56
Fellows	390
Members	14,252
Affiliates	318
Associate Members (33 and over)	3,585
Associate Members (30–32)	3,156
Associate Members (to the age of 29)	17,181
Total	38,938

1954 Heat Transfer and Fluid Mechanics Institute

The 1954 Heat Transfer and Fluid Mechanics Institute, which was held in Dwinelle Hall on the Berkeley Campus of the University of California, June 20–July 2, was well attended.

The seventh such institutes attracted the attention of more than 125 representatives from eight universities and several petroleum laboratories and aircraft manufacturing companies.

Copies of the 1954 preprints (see program published in the June, 1954, issue of Mechanical Engineering, page 549) may be purchased from The Stanford University Press, Stanford, Calif., for $5.50.

Institute of Management Sciences Established

A New national society, The Institute of Management Sciences, has been established with the objective of unifying scientific knowledge that contributes to the understanding and practice of management. The Institute will publish a journal, *Management Science*, which will include research papers and survey papers dealing with scientific analysis and theory of management. Prof. C. W. Churchman, of Case Institute of Technology, has been appointed managing editor.

Prof. W. W. Cooper, Carnegie Institute of Technology, has been elected president of the Institute. Information on membership or subscriptions can be obtained from George Kozmetsky, Litton Industries, Beverly Hills, Calif.

Group of scientists and engineers who attended 1954 ASME West Coast Applied Mechanics Conference, at the University of California on the Berkeley Campus

Ninth Annual ASME Petroleum Mechanical-Engineering Conference to Be Held in Los Angeles, Sept. 26–29, 1954

THE Petroleum Division of The American Society of Mechanical Engineers is holding its ninth annual Petroleum Mechanical-Engineering Conference in the Statler Hotel, Los Angeles, Calif., Sept. 26–29, 1954. This year's conference will be held in co-operation with the Southern California Section of ASME. The latest technical information in the fields of refining, production, and transportation of petroleum will be presented at the 18 sessions scheduled for the conference. Thirty-five papers are on the program. In addition there will be two forums and a panel session. The Industry Luncheons, the banquet, and inspection trips to local industries will round out the conference program.

Technical Sessions

Petroleum mechanical engineers will have a wide choice of technical sessions to attend. In the refining field, the technical program will offer such subjects as mechanical features of new processes, mechanical design, and maintenance. Production sessions will take up underground engineering, welding of drill collars, tubular goods, drilling operations, slush-pump operation, and production equipment. Sessions devoted to transportation will cover pipe-line design and operation, storage and transmission of hydrocarbons, and oil and gas pipe-line station equipment. Six papers will be delivered on the materials phase of petroleum mechanical engineering. In addition, there will be a special session on gas-turbine applications arranged by the Gas Turbine Division of the ASME Southern California Section. E. G. Naylor of General Electric Company will be the speaker.

Two Forums and a Panel

Special events will include a code forum on refinery pipe, at which the American Standard Code for Pressure Piping will be discussed, and a forum on the subject, A Look Ahead in Pressure-Vessel Design. On Monday, a panel session on Oil and Gas Transmission Lines, Application of Code for Pressure Piping, is scheduled. Moderator at this panel session is F. A. Hough, vice-president, Southern Counties Gas Company, Los Angeles, Calif.

Social Events

Among the social events will be a welcome luncheon to be held in the Ballroom on Monday. Eugene Biscailez, Sheriff of Los Angeles County, will be on hand to welcome the guests to Los Angeles. The popular Industry Luncheons are scheduled for Tuesday, Sept. 28. At these luncheons, usually well attended, petroleum mechanical engineers have an opportunity to become acquainted with other men in their particular branch of the industry. The following branches have luncheons scheduled: Refining, Transportation, Production, Materials, and Manufacturing. High spot of the conference is expected to be the Banquet on Tuesday. At the Banquet, O. L. Lewis, chairman, ASME Petroleum Division, will present the Student Award. L. K. Sillcox, president ASME will talk on "Trade and Technology," at the Welcoming Luncheon.

Preprint Orders

ONLY preprints of *numbered* ASME papers will be available. Some of these papers may not be available in time to permit your receiving them in advance of the meeting. Your order will be mailed only when the complete order can be filled unless you request that all papers available ten days before the meeting be mailed at that time. Please order only by paper *number;* otherwise the order will be returned. The final listing of available technical papers will be found in the issue of MECHANICAL ENGINEERING containing an account of the meeting.

Preprints of ASME papers may be obtained by writing to the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Papers are priced at 25 cents each to members, 50 cents to nonmembers. Payment may be made by check, U. S. postage stamps, free coupons, or coupons which may be purchased from the Society. The coupons, in lots of ten, are $2 for members; $4 for nonmembers.

Preprints of unnumbered papers listed in the tentative program are not available because the review of these manuscripts had not been completed when the program went to press. The author's name and preprint number will appear with the paper title in the final program (final program available only at meeting) as well as the issue of MECHANICAL ENGINEERING containing an account of the meeting, if the paper is recommended for preprinting.

Inspection Trips

Engineers and guests attending the conference will have an opportunity to take a boat tour of Long Beach Harbor said to rank with the most modern harbors in the United States. Other trips will be to the Watson Refinery of the Richfield Oil Corporation, the Ammonia plant of the Brea Chemical Company, and the Union Oil Company Research Center at Brea, Calif.

Women's Program

A program has been arranged to interest the women attending the conference. On Tuesday, September 28, there will be a luncheon at the Beverly Hills Hotel. After the luncheon, a sightseeing tour has been arranged through the Beverly Hills Shopping Center and the Farmers Market.

The scene of the tenth Conference of the ASME Petroleum Division will be New Orleans, La., at the Hotel Jung, Sept. 25–28, 1955.

The technical program follows:

MONDAY, SEPTEMBER 27

9:00 a.m.

Session (1)—Mechanical Features of New Processes

Mechanical Features of the Hyperforming Process, by *Clyde Berg*, Union Oil Company of California (Paper No. 54—PET-3)

Mechanical Advancements in the Alkylation Process, by *Robert Stiles*, The M. W. Kellogg Co.

Session (2)—Underground Engineering

Excavated Underground Storage for Petroleum Products, by *R. L. Loofbourow*, consulting engineer

In-Situ Combustion Oil-Recovery Process—Installation for Field Experiment in Jefferson County, Okla., by *R. L. Koch, J. F. Gleason, Jr.*, and *W. G. Boston*, Magnolia Petroleum Co. (Paper No. 54—PET-13)

Session (3)—Pipe-Line Design and Operation

Wind-Induced Vibration of a Pipe-Line Suspension Bridge and Its Cure, by *Raymond C. Baird*, The Fluor Corp. (Paper No. 54—PET-12)

A Damper for Wind-Induced Bridge Vibration—Experimental Studies, by *Raymond C. Baird* and *Alvin J. Ebersole*, The Fluor Corp. (Paper No. 54—PET-11)

The Use of Electronic Digital Computers in Pipe-Line Design and Operation, by *T. Y. Hicks*, International Business Machines Corp., and *C. V. Rohleder*, Service Pipe Line Co.

12:00 noon

Welcoming Luncheon

Presiding: *L. F. Richardson*, chairman, Southern California Section, ASME
Welcome: *Eugene Biscailez*, Sheriff of Los Angeles County
Address: *L. K. Sillcox*, ASME President
Subject: **Trade and Technology**

2:00 p.m.

Session (4)—Mechanical Design (1)

Economics of Design of Heat Exchangers, by *E. D. Anderson*, Western Supply Co.

Design Problems and Applications of High-Speed Turbines, by *H. Steen-Johnsen*, Elliott Co. (Paper No. 54—PET-3)

Session (5)—Welding of Drill Collars

Pressure-Weld Technique for Stub-Ending Drill Collars, by *John L. Dickman*, Baash Ross Tool Co.

Electric-Arc Technique for Stub-Ending Drill Collars, by *W. S. Bachman*, Drilco Oil Tools, Inc.

Session (6)—Oil and Gas Transmission Lines, Application of Code for Pressure Piping. Panel session

Chairman: *T. D. Williamson*, T. D. Williamson, Inc.
Vice-Chairman: *W. S. Bissell*, Shell Oil Co.
Moderator: *F. A. Hough*, Southern Counties Gas Co.
Panel Members: *J. C. Stirling*, Service Pipe Line Co.; *W. P. Kliment*, Crane Co.; *O. W. Heydon*, Shell Pipe Line Co.; *Milton Ludwig*, Standard of California; *C. W. Wheatley*, A. O. Smith Co.; *F. S. G. Williams*, Taylor Forge & Pipe Works; *B. D. Goodrich*, Texas Eastern Transmission Corp.; and *J. J. King*, Tennessee Gas Transmission Co.

Session Arranged by Gas Turbine Division of Southern California Section

8:00 p.m.

Speaker: *E. G. Naylor*, General Electric Co.
Subject: **Gas-Turbine Applications**

TUESDAY, SEPTEMBER 28

9:00 a.m.

Session (7)—Maintenance

Field Co-Ordinating Organization for Improving Efficiency of Petroleum Refinery Maintenance, by *E. C. Hermann*, Esso Standard Oil Co. (Paper No. 54—PET-4)

Field Welding of Heavy Wall Vessels, by *F. A. Upson*, Standard Oil Co. (Paper No. 54—PET-5)

Session (8)—Tubular Goods

Techniques Developed in Testing Reinforced Polyester Pipe, by *H. D. Boggs* and *D. R. Longenecker*, Fibercast Corp. (Paper No. 54—PET-14)

Resistance of Tubing Materials to Sulphide Corrosion Cracking, by *J. P. Fraser* and *R. S. Treseder*, Shell Development Co.

Session (9)—Materials

The Influence of High-Strength Materials on the Design and Fabrication of Multilayer Vessels, by *G. E. Fratcher*, A. O. Smith Corp.

Report on the Protection of Off-Shore Steel Structures by Metallurgical Methods, by *B. B. Morton*, International Nickel Co.

Adapting Radiography to Petroleum Industry Needs, by *Harold Hovland*, Industrial X-Ray Engineers (Paper No. 54—PET-17)

12:00 noon

Industry Luncheons

Refining, Transportation, Production, Materials, and Manufacturing Committees to hold separate luncheons

2:00 p.m.

Session (10)—Refinery-Pipe Code Forum

Chairman: *H. W. Evans*, Sinclair Oil and Gas Co.
Vice-Chairman: *R. V. Gunther*, Southwest Engineering Co.
Subject: **The American Standard Code for Pressure Piping,** by *F. S. G. Williams*, Taylor Forge & Pipe Works (Paper No. 54—PET-1)
Panel Members: *F. S. G. Williams*, Taylor Forge & Pipe Works; *J. P. Mooney*, Humble Oil and Refining Co.; *N. J. Rees*, Socony-Vacuum Oil Co.; *K. W. Haupt*, Pipe Fabrication Institute; *C. M. Vogrin*, The M. W. Kellogg Co.; *J. J. Kanter*, Crane Co.; and *E. B. Stolle*, Midwest Piping Co.

Session (11)—Drilling Operations

The Design of Offshore Drilling Structures, by *Richard J. Howe*, Shell Oil Co.

Pressure Surges While Running Pipe, by *E. H. Clark, Jr.*, Baker Oil Tools, Inc.

The Development of a Rubber Sealed Valve for Oil-Well Drilling, by *L. H. Carr*, Edward Valves, Inc. (Paper No. 54—PET-15)

Session (12)—Storage and Transmission of Hydrocarbons

Handling Viscous Crude Oils by Pipe Line, by *Morgan Martin*, Gulf Refining Co. (Paper No. 54—PET-10)

Economics and Operation Procedure of Crude Oil Tank Mixers, by *Neil G. Wilson*, Shell Pipe Line Corp.

6:00 p.m.

Social Hour

7:00 p.m.

Banquet

Presiding: *L. F. Strader*, general chairman, conference arrangements committee. Remarks and Presentation of Student Award: *O. L. Lewis*, chairman, Petroleum Division, ASME
Address: *J. W. Jensen*, Tidewater Associated Oil Co.
Subject: **The Importance of Water to Industry**

WEDNESDAY, SEPTEMBER 29

Session (13)—Mechanical Design (2)

9:00 a.m.

Allowable Membrane Stresses for Welded Carbon-Steel Boiler and Pressure Vessels, by *W. P. Kerkhof*, Asiatic Petroleum Corp. (Paper No. 54—PET-6)

Stresses From Local Loadings in Cylindrical Pressure Vessels, by *P. P. Bijlaard*, Cornell University (Paper No. 54—PET-7)

Space Supports—The Circular Pedestal, by *N. A. Weil* and *J. J. Murphy*, The M. W. Kellogg Co. (Paper No. 54—PET-8)

Session (14)—Slush-Pump Operation

Principles of Duplex Slush-Pump Operation, by *R. L. Walker* and *R. A. Tappmeyer*, Shell Oil Co. (Paper No. 54—PET-16)

The Application of V-Belt Drives to Slush Pumps, by *W. S. Worley*, The Gates Rubber Co.

Session (15)—Materials

The Use of Metallic and Nonmetallic Linings for Pressure Vessels in Refinery Service, by *S. J. Artese*, Shell Oil Co.

Glass Coating as a Corrosion Barrier, by *W. A. Deringer*, A. O. Smith Corp. (Paper No. 54—PET-18)

Hydrogen Blisters in Transmission Line and Preventive Measures, by *Felipe Parades* and *W. W. Mise*, El Paso Natural Gas Co.

12:00 noon

Luncheons

2:00 p.m.

Session (16)—Unfired Pressure Vessel Forum

Chairman: *W. O. Long*, The Fluor Corp.
Vice-Chairman: *R. M. Willits*, General Petroleum Corp.
Subject: **A Look Ahead in Pressure-Vessel Design,** by *E. W. Jacobson*, Gulf Research and Development Co. (Paper No. 54—PET-9)
Panel Members: *H. C. Boardman*, Chicago Bridge and Iron Co.; *F. S. G. Williams*, Taylor Forge & Pipe Works; *N. J. Rees*, Socony-Vacuum Oil Co.; *F. W. Wilson*, Mathieson Chemical Corp.; *D. B. Rossheim*, The M. W. Kellogg Co.; *M. A. Scheil*, The A. O. Smith Corp.; and *E. O. Bergman*, C. F. Braun & Co.

Session (17)—Production Equipment

Vapor-Conservation Measures for Low-Pressure Producing Equipment, by *Walter E. Huffman*, Black-Sivalls and Bryson, Inc.

Power Actuation of Flow Valves for Automation of Lease Operations, by *Alexander A. Toben*, Ledeen Manufacturing Co.

Session (18)—Oil and Gas Pipe-Line Station Equipment

The Free Piston Gas Turbine Prime Mover, by *R. P. Ramsey*, The Cooper-Bessemer Corp.

Automatic Control Systems—Electronic, Hydraulic, and Pneumatic, by *Roger Gilliand*, The Swartwout Co.

First ASME-ASLE Annual Lubrication Conference, Baltimore, Md., Oct. 18-19

THE first lubrication conference sponsored jointly by The American Society of Mechanical Engineers and the American Society of Lubricating Engineers, to be held at the Lord Baltimore Hotel, Baltimore, Md., Oct. 18-19, is a giant step toward gathering all of the most recent developments in lubrication over the past year. Approximately 18 papers will be presented. Two sessions will be held daily, with an evening session scheduled for October 18.

The ASME Lubrication Activity and ASLE, having one specific field in common, designed this conference to offer advantages far greater than those offered by individual conferences. The conference will provide a meeting place where engineers directly concerned with lubrication problems will present and discuss their findings and views.

Technical Sessions and Committee Meetings

Monday, October 18

8:30 a.m. Registration

10:00 a.m. Session 1, Hydrostatic Bearings

An Analysis of Orifice-Compensated Hydrostatic Journal Bearings, by *A. A. Raimondi* and *John Boyd*, Westinghouse Research Laboratories, East Pittsburgh, Pa.

A Preliminary Investigation of an Air-Lubricated Hydrostatic Thrust Bearing, by *Lazar Licht*, Columbia University, and *D. D. Fuller*, Columbia University and The Franklin Institute Laboratories for Research and Development, Philadelphia, Pa.

Behavior of Air in the Hydrostatic Lubrication of Loaded Spherical Bearings, by *T. L. Corey, H. H. Rowand, Jr., E. M. Kipp*, Aluminum Company of America, New Kensington, Pa., and *C. M. Tyler, Jr.*, Carnegie Institute of Technology, Pittsburgh, Pa.

1:30 p.m. Session 2, Hydrodynamic Bearing Analysis

Recent Advances in the Hydrodynamic Theory of Slider-Bearing Lubrication, by *F. Osterle* and *E. Saibel*, Carnegie Institute of Technology, Pittsburgh, Pa.

On the Solution of Reynolds Equation for Slider-Bearing Lubrication, (9) The Stepped Slider with Adiabatic Lubricant Flow by *F. Osterle, A. Charnes*, and *E. Saibel*, Carnegie Institute of Technology, Pittsburgh, Pa.

Studies in Lubrication, (10) The Complete Journal Bearing with Circumferential Oil Inlet, by *M. J. Jacobson*, Bell Telephone Laboratories, Inc. Whippany, N. J.; *A. Charnes* and *E. Saibel*, Carnegie Institute of Technology, Pittsburgh, Pa.

The Short Bearing Approximation for Plain Journal Bearings, by *G. B. Du Boise* and *F. W. Ocvirk*, Cornell University, Ithaca, N. Y.

Power Loss in Elliptical and Three-Lobe Bearings, by *Oscar Pinkus*, General Electric Co., Lynn, Mass.

5:30 p.m. Dinner Meeting—ASME Lubrication Activity Design Group

8:00 p.m. Session 3, Bearing Instability

Investigation of Translatory Fluid Whirl in Vertical Machines, by *B. Sternlicht* and *G. F. Oeker*, Columbia University, New York, N. Y.

Oil Film Whirl—An Investigation of Disturbances Due to Oil Films in Journal Bearings, by *Burt L. Newkirk*, Schenectady, N. Y., and *John F. Lewis*, Troy, N. Y.

Turbulence in Water-Lubricated Thrust Bearings, by *Stanley Abramovitz*, The Franklin Institute Laboratories for Research and Development, Philadelphia, Pa.

Tuesday, October 19

8:30 a.m. Registration

9:30 a.m. Session 4, Rolling Element Bearings and Cams

Materials and Designs of Cages for High-Speed Roller Bearings, by *Messrs. Anderson* and *Nemeth*, Cleveland, Ohio

Power Loss Measurements of High-Speed Ball Bearings, by *C. C. Moore* and *F. C. Jones*, General Electric Co., West Lynn, Mass.

Hydrodynamic Lubrication of a Cam and Cam Follower, by *Robert Davies*, General Motors Corp., Detroit, Mich.

A Progress Report on the Surface Endurance Limits of Engineering Materials, by *G. J. Talbourdet*, United Shoe Machinery Corp., Beverly, Mass.

1:30 p.m. Session 5, Friction and Lubricants

Friction in a Close-Contact System, by *Walter Claypoole*, Columbia University, New York, N. Y.

The Statistical Nature of Friction, by *E. Rabinowics* and *B. G. Rightmire*, Massachusetts Institute of Technology, Cambridge, Mass.; and *C. E. Tedholm*, San Francisco, Calif.; and *R. E. Williams*, Curtis Bay Coast Guard Yard, Md.

An Analysis of Recent Data on the Effects of Temperature and Pressure on the Viscosity of Lubricants, (1) Paraffinic and Naphthenic Base Oils, by *R. B. Dow*, Bureau of Ordnance, Navy Department, Washington, D. C.

Some Experiments on the Flow of Oil and Grease through Tubes of Circular Cross Section, by *H. E. Mahncke* and *W. Tabor*, Westinghouse Research Laboratories, East Pittsburgh, Pa.

Wednesday, October 20

ASME Lubrication Activity Committee Meetings

9:00 a.m. (all day) ASME Research Committee on Lubrication

1:00 p.m. ASME Lubrication Activity—Rolling Element Bearings

2:00 p.m. ASME Lubrication Activity—Fluid Film Bearings

3:00 p.m. ASME Lubrication Activity—Boundary Lubrication and Bearing Materials

4:00 p.m. ASME Lubrication Activity—Lubricants

5:00 p.m. ASME Lubrication Activity—Research Group

Meetings of Other Societies

Sept. 12–16
American Institute of Chemical Engineers, national meeting, Hotel Colorado, Glenwood Springs, Colo.

Sept. 13–17
Illuminating Engineering Society, 46th national technical conference, Chalfonte-Haddon Hall, Atlantic City, N. J.

Sept. 13–23
Fourth European machine tool exhibition, Milan, Italy.

Sept. 19–26
International foundry congress; Italian Society of Metallurgy, 22nd international congress, Florence, Italy

Sept. 20–23
American Mining Congress, metal and nonmetallic mining convention and exposition, Civic Auditorium, San Francisco, Calif.

Sept. 20–25
Steinkohlenbergbauverein, second international congress on coal refining, Essen, Germany

Sept. 24–25
International mechanical engineering congress, automation of measuring during machining, Stressa, Italy

Sept. 27–28
Atomic Industrial Forum, meeting on "What the New (atomic energy) Law Means," Hotel Plaza, New York, N. Y.

Sept. 27–29
American Institute of Electrical Engineers, first "electrical conference of the petroleum industry," Mayo Hotel, Tulsa, Okla.

Sept. 27–Oct. 2
Engineering Societies of Europe and U. S. (EUSEC), International Committee on Engineering Education, second international conference, Zurich, Switzerland

Sept. 28–Oct. 1
Association of Iron and Steel Engineers, iron and steel exposition, Cleveland Public Auditorium, Cleveland, Ohio

Oct. 4–6
The tenth annual National Electronics Conference, Hotel Sherman, Chicago, Ill.

Oct. 4–9
Society of Automotive Engineers, national aeronautic meeting, Hotel Statler, Los Angeles, Calif.

Oct. 5–9
American Institute of Mining and Metallurgical Engineers, industrial minerals, fall meeting, Whiteface Inn, Lake Placid, N. Y.

Oct. 6–7
Institute of Radio Engineers Professional Group on nuclear science, first national meeting, Sherman Hotel, Chicago, Ill.

Oct. 11–15
American Institute of Electrical Engineers, fall meeting, Morrison Hotel, Chicago, Ill.

(ASME Calendar of Coming Events, see page 787)

The ASME Program Makers Conference was held recently in New York, N. Y., to report progress made in crystallizing plans for the five national meetings which will mark the Society's 75th Anniversary. Carrying out the theme—the engineer and the world he lives in—two of the major events will commemorate dates important in the founding of the Society, and three will be held when national meetings would usually be in session. Detlev W. Bronk, it was announced, will be guest banquet speaker at the Boston, Mass., Meeting. His talk will be based on the engineer in the world of science. A few of the large group in attendance at the meeting, who make up the 75th Anniversary Committee, are shown seated, *left to right*, J. T. Rettaliata, chairman, Technical Events, Chicago, Ill., Meeting; J. K. Louden, chairman, Meetings Committee; A. M. Gompf, general chairman, Baltimore, Md., Meeting; standing, *left to right*, C. W. Parsons, secretary, and R. H. Bacon, general chairman, Chicago Meeting; and E. H. Hanhart, chairman, Technical Events, Baltimore Meeting. Founding Anniversary Meeting, Feb. 16, 1955, first major event.

Coming Meetings . . .

IEC Jubilee in Philadelphia

FOLLOWING is a list of the meetings of interest to ASME that have been scheduled during the International Electrotechnical Commission Jubilee in Philadelphia, Pa., in September, 1954. All of these meetings are being held at the University of Pennsylvania.

Date	*Meeting*	*Building*
Sept. 1–3 10:00 a.m.	Fourth International Conference on Properties of Steam	Room 212, Moore School of Electrical Engineering
Sept. 1–4 9:30 a.m.	IEC/TC/4 on Hydraulic Turbines	Houston Hall
Sept. 7, 8, 10, 11 9:30 a.m.	IEC/TC/5 on Steam Turbines	Houston Hall
Sept. 14–16 9:30 a.m.	IEC/TC/19 on Internal-Combustion Engines	Houston Hall
Sept. 10 8:00 p.m.	ASME Power Test Codes Committee	Benjamin Franklin Room, Houston Hall

Industrial Engineering

MICHIGAN State College will hold its sixth annual Industrial-Engineering Conference, Sept. 13–17, 1954.

The week-long meeting will consist of daily general sessions and several subject discussion groups. Topics to be discussed include: Beginning motion and time study; advanced motion and time study; plant layout and materials handling; industrial engineering for small plants; production control; and quality control.

For further details, write to Prof. James M. Apple, mechanical-engineering department, Michigan State College, East Lansing, Mich.

ASME Elects Nine Fellows . . .

The American Society of Mechanical Engineers has honored nine of its members by electing them to the grade of Fellow of the Society.

To be qualified as a nominee to the grade of Fellow one must be an engineer with acknowledged engineering attainment, 25 years of active practice in the profession of engineering or teaching of engineering in a school of accepted standing, and a member of the Society for 13 years. Promotion to the grade of Fellow is made only on nomination by five Fellows or members of the Society to the Council, to be approved by Council.

The men whose outstanding contributions to their profession and to the Society were so honored are:

Philip Langdon Alger

Philip L. Alger, consulting engineer, medium induction-motor department, General Electric Company, Schenectady, N. Y., has distinguished attainments in the science of engineering, in the broad field of professional engineering, and related sciences. His technical leadership touching all products in the G-E apparatus department has affected the technical design and performance of these products. Within the company he is known for his teaching, analysis of technical problems, and stimulation of men and ideas. He has carried the staff responsibility of the department manager of engineering for planning and co-ordination of electrical-machinery development for the past 20 years. He is noted for his contribution to the technical knowledge of synchronous and rotating induction machinery. He holds 11 patents relating to the design of these machines and has made many technical studies in this field. He has written several papers which have been major contributions to the understanding of these machines. His mathematical ability has been applied in his work as a member of the Scientific Advisory Committee of the Balistics Research Laboratory of the U. S. Army. He has long taken an active interest in engineering education and was closely associated with the establishment of several G-E engineering courses. Mr. Alger is the author of several technical papers published in various professional journals and of the book, "The Nature of Polyphase Induction Machines," 1951; coauthor of "Induction Machines and Alternating-Current Commutator Motors," Standard Handbook for Electrical Engineers, eighth edition, 1949; and the article on Electric Generators for the Encyclopedia Britannica, 1938. He is a director of the New York State Citizens Council and the Schenectady Bureau of Municipal Research; he has served as chairman of the Charter League that sponsored the City Manager Plan for Schenectady. He holds membership in many leading professional societies both at home and abroad.

Ralph Masser Barnes

Ralph M. Barnes, professor of engineering and production management, University of California, Los Angeles, Calif., is known for his outstanding work in the fields of industrial engineering and management. His major contribution to management is the fundamental research he has conducted in industrial engineering. He has developed an extensive film library of motion and time-study applications useful to industry and of educational films showing techniques and principles. Before going to the University of California, he taught for 21 years at the University of Iowa. Among other accomplishments during this period he developed the curriculum in industrial engineering and aided in expanding and enlarging course offerings; developed and equipped the University's industrial-engineering laboratory; developed and directed the industrial-engineering research program; and originated and directed the University's management course, 1939–1948. He has made many contributions to the industrial-engineering field through his industrial consulting assignments. He assisted in developing the Industrial Engineering Center of Armstrong Cork Company, Lancaster, Pa., and served as its first director. In 1950 he developed and presented a special industrial-engineering course for engineers and managers from Norway and Sweden. He is the author of several books, including: "Industrial Engineering and Management," 1931; "Motion and Time Study," third edition, 1949; "Motion and Time Study Problems and Projects," 1949, and "Motion and Time Study Applications," second edition, 1953. He has written over 60 papers in this field. Professor Barnes has been active in ASME affairs and is now a member of the Executive Committee of the Management Division; and a member of the General Management Research Committee.

Fred Denig

Fred Denig, vice-president in charge of production department, central staff, Koppers Company, Inc., Pittsburgh, Pa., has made many important contributions to the coke and manufactured-gas industries since joining Koppers in 1921. Mr. Denig has developed new and useful improvements in equipment and operating techniques. Under his guidance several new processes, many improvements in other processes, and in some of the products of the coke industry have been developed. These include new processes for purification of fuel gases, processes for treatment of effluents from coke plants, new or improved methods for the extraction of chemical products from coke plants, and improvements in the quality of coke and techniques of producer-gas manufacture. During World War II, under his direction, the research department of Koppers developed a series of processes to make both butadiene and styrene, the components of synthetic rubber, from coke-oven benzene. When benzene became unavailable, Koppers was authorized to build and operate a plant to manufacture these components according to the principles of the processes of Carbide and Carbon Chemical Corporation. Synthetic-rubber components from this plant were available for manufacture of desperately needed rubber early in the war and far ahead of plants based on petroleum raw materials. Mr. Denig is credited with being the "main spring" who activated this important engineering accomplishment. Since then he has been connected with several important developments in the field of synthetic chemicals and of gas synthesis. He was responsible for bringing the Koppers-Totzek process for total gasification of coal to the U. S. A. and largely instrumental in its first tryout at Louisiana, Mo. He has written several papers. He contributed the chapter on Industrial Coal Carbonization to the book, "Chemistry of Coal Utilization." He holds 11 patents.

William Victor Drake

William V. Drake, vice-president, power department, West Penn Power Company, Pittsburgh, Pa., is an outstanding power engineer. Before joining his present company he was employed by the Monongahela Power Company, Fairmont, W. Va., from 1928 to 1949. He became manager of power generation of this company in 1931 in charge of operation and maintenance of all power facilities. In 1949 he joined his present company as manager of power production. His engineering judgment, vision, organization, and managerial skill has contributed greatly to the success of his company. To him goes a large measure of the credit for the technical integration of this large system. He is principally responsible for its generating plants' successful handling of unusually high service demands. In 1945 he was selected to head a party of engineers making a survey of power facilities of Formosa and North China for the National Resources Commission, Nationalist Government, for J. G. White Engineering Corporation, New York, N. Y. The report on the project included recommendations on operation and maintenance of present facilities, recommendations on new power facilities, and a study on hydro versus steam-power additions. In 1952 he was recalled to Formosa as a consultant, for two months, to survey the power facilities of the Taiwan Power Company. Recommendations which he made for new power sites, type and size equipment to be installed, are at present being carried out.

George Merrick Dusinberre

George M. Dusinberre, professor of mechanical engineering, Pennsylvania State College, State College, Pa., is known as an outstanding teacher of engineering. His principal contribution to engineering is his book, "Numerical Analysis of Heat Flow," McGraw-Hill, 1949, which has been extremely useful to practicing engineers in mechanical and chemical industries. It has enabled the solution of heat-conduction problems which had never been possible by classical methods, thus often avoiding costly analog solutions or costly trial-and-error procedures. The major part of the book is original with the author and it has constantly been referred to in the subsequent literature. As a teacher, Professor Dusinberre has had many students who have become successful in various fields

of engineering. He was formerly an instructor at the U. S. Naval Academy, Annapolis, Md., where he contributed largely to the writing of a thermodynamics text used at the Academy since 1937. From 1940 to 1946 he was in charge of planning courses of instruction for last-year students and selection and supervision of instructors at the Academy. He also initiated instruction in gas turbines. He has taught thermodynamics and heat transfer at the Virginia Polytechnic Institute, Blacksburg, Va., and at the University of Delaware, Newark, Del. He has been active in ASME affairs, especially on the Papers Committee of the Heat Transfer Division of which he was chairman for two years. At present he is on the Executive Committee of this Division. He is also a member of the Executive Committee of the ASME Central Pennsylvania Section. He has written several papers and is the author of a book on gas-turbine power, published in 1952.

Reinout Pieter Kroon

R. P. Kroon, chief engineer, aviation gas-turbine division, Westinghouse Electric Corporation, Philadelphia, Pa., is known for his leadership in the development of the first American design of a turbojet power plant for aviation service and for his technical leadership in many fields which have contributed to the advance of aviation. Since its inception at Westinghouse in 1941, the technical direction of aviation turbojet-engine development has been Mr. Kroon's responsibility. Basic in the design objectives was high power within a small diameter. This was accomplished by using an axial-flow compressor with an integral annular combuster, each developed for the first time for aviation use. In 1934 Mr. Kroon conceived and developed means for measuring and recording low-pressure turbine-blade natural vibration frequencies, with the bladed wheel operating at speed. The optical-exploration system he first developed has contributed substantially to the building of larger and more reliable turbines than would otherwise have been practicable. In 1938 he conceived and developed a novel prestressed gimbal structure for the 200-in. Mt. Palomar telescope, transferring the 250,000-lb tube weight to its trunnions in a manner rendering tube alignment immune to distortion of its support. He was largely responsible for novel oil-flotation bearings used in this telescope. Mr. Kroon was the 1950 recipient of the ASME Spirit of St. Louis Medal. He was chairman of the ASME Aviation Division in 1947 and chairman of the Applied Mechanics Division in 1950. Mr. Kroon has written many technical papers. He holds 12 patents.

Frank Kenneth Mitchell

Frank K. Mitchell, assistant vice-president, equipment, New York Central System, New York, N. Y., has made many contributions to the railroad industry. For over 20 years, from 1918 to 1940, he was with the C.C.C. and St. Louis Railway, rising from mechanic to assistant superintendent of motive power. In 1940 he joined the New York Central Railroad as assistant to the general superintendent, motive power and rolling stock, in charge of locomotive shops. During World War II he was chairman of the Office of Defense Transportation Mechanical Advisory Committee, Eastern Region Railroads. He served on the Special Committee recommending layouts, tools, and equipment for Army shops and locomotive and car-maintenance terminals. Since 1940 he has collaborated in the design and development of the following: The Niagara-type steam locomotive; the hump trailer for diesel switching service; the sealed-beam locomotive headlight; the spline axle generator drive for head-end cars and cabooses; air-conditioned multiple-unit suburban car; and the cast-steel underframe for drop-end gondola cars. He has also contributed to the development of a Railway Apprentice Training System and a special apprentice training course for college graduates. He has served the Society as chairman of the Standardization Committee, 1950; the Board on Codes and Standards, 1948–1950; and the Railroad Division General Committee, 1950–1954. He is the author of many technical and nontechnical papers.

Arthur Frederic Murray

Arthur F. Murray is vice-president in charge of manufacturing of the Electrolux Corporation, Old Greenwich, Conn. Before joining this company he was with the Westinghouse Electric and Manufacturing Co. from 1919 to 1943. During World War I he was with a Westinghouse subsidiary producing rifles and machine guns. Before then he was with several concerns making small arms, typewriters, and pumping machinery. Mr. Murray pioneered in the development of methods for mass production and materials handling in radio-set manufacture. He aided in developing systematic methods of reducing manufacturing costs and new methods of mass-producing small motors, other electric appliances, and radio receiving sets. He helped to organize production of the Westinghouse refrigerator—one of the first hermetically sealed designs. He worked on the development of air-conditioning units for railroad cars and assisted in developing new controlled ceramic drying equipment in the Westinghouse Porcelain Insulator Plant. From 1939 to 1942 he worked with Special Defense and War Product Sales in evaluating requests for participation in many projects and assisting in preparations for production. He worked on projectiles, gun mounts, fuses—including early secret development of proximity fuse—gun stabilizers, and many other special products.

He joined Electrolux in 1943. During World War II he was in full charge of producing many types of precision small motors, dynamotors, selsyns, and the like, for the Armed Services. His plant was awarded the Army Navy "E" with three stars. Mr. Murray has written many papers. He is active in ASME affairs. In 1949 he was chairman of the Production Engineering Division and presently he is chairman of the Committee on Standards of Accuracy of Engine and Tool-Room Lathes.

Burt Leroy Newkirk

Burt L. Newkirk, professor emeritus and consultant, Rensselaer Polytechnic Institute, Troy, N. Y., has had a distinguished career both as an engineer and as a teacher. Professor Newkirk taught at the University of Minnesota, Minneapolis, Minn., from 1907 to 1920. During his years on the faculty he patented and licensed for manufacture the precision-balancing machine based on the Newkirk process. His outstanding work in the elimination of the roughness from the operation of high-speed turbine generators during a sabbatical year spent at the General Electric Company, Schenectady, N. Y., resulted in his joining the G.E. Research Laboratory. He remained at General Electric for 16 years. He conducted notable investigations on the behavior of high-speed shafts while at the same time doing important "shirt-sleeve" work on the actual operation of the largest blast-furnace blowers then built. Returning to the teaching profession at Rensselaer Polytechnic Institute in 1937, he transmitted to many young engineers a sound understanding of the vibration theory, one of the most important branches of mechanical engineering. As professor emeritus at Rensselaer, he is continuing to be an active consultant both to the faculty and to manufacturers of heavy apparatus. He recently made valuable contributions in connection with vibration problems. He is currently engaged on an investigation of shaft disturbances due to the action of oil films in journal bearings, for the Air Force. He is serving ASME as chairman of the ASME Research Committee on Lubrication and also as chairman of a newly organized research group on lubricating activities. Professor Newkirk has written numerous papers. He holds nine patents.

C. F. Roth, Power Show Manager, Dies

Charles F. Roth, president of the International Exposition Company and manager of the National Exposition of Power and Mechanical Engineering (Power Show), died June 24, as the result of an automobile accident. He was born in New York, N. Y., Dec. 24, 1886, son of Charles and Annie (Hart) Roth. He was graduated from Cooper Union in 1912 with a degree in chemistry. In 1915, while chief chemist for the Standard Oil Company of New York, he organized the Chemical Exposition as an aid in relieving the strategic material shortages of World War I. During the same period he served as consulting chemist for the International Filtration Corporation and director of the Beckman and Linden Engineering Corporation. In a career of 40 years, he organized and managed more than 60 industrial expositions.

Mr. Roth was active in the affairs of the American Chemical Society since 1911 and held memberships in many other organizations. He had won many awards for his work in chemistry, including the Cooper Medal.

He is survived by his widow, Mrs. Carol Thrall Roth; a sister, Miss Anita Roth; and a grandson, Charles R. MacDonald.

Junior Forum

Conducted by Joseph Schmerler, Assoc. Mem. ASME

ASME Presidents, Associate Members, and guests of Old Guard, discuss Engineering Success with H. N. Muller, Jr., following the Junior Session. Shown, *left to right,* are: Ralph Yohn, Central Pennsylvania; R. W. Wixom, Akron; C. F. Simon, Jr., Erie; Dennis Jones, Westmoreland; J. E. Harder, vice-chairman, Junior session, Pittsburgh; F. S. Blackall, jr., past-president, ASME; R. A. Cederberg, chairman, Junior Session, Pittsburgh; L. K. Sillcox, ASME President; H. N. Muller, Jr., main speaker, Pittsburgh; George Anderson, Canton-Alliance-Massillon; Clair Leonard, Youngstown; Robert Smith, Columbus; and John Reber, Jr., Susquehanna.

H. N. Muller Defines Engineering Success at Pittsburgh Junior Session

By R. A. Cederberg[1] and J. E. Harder[2]

One of the high lights of the ASME Semi-Annual Meeting in Pittsburgh, June, 1954, was the Junior Session at which H. N. Muller, Jr., assistant to the vice-president engineering, Westinghouse Electric Corporation, outlined systematically for a group of more than 100 engineers some of the measures by which a man may judge his own success.

Mr. Muller introduced his subject by stating that the only person who can judge a man's success is that man himself. Others may judge the merits and demerits of his work, but only the individual is in a position to judge his own success. In order to get the proper perspective to judge his own success, Mr. Muller felt that the individual should "place himself in the position of the senior member of the profession who can look back on his career and his attainment."

Five Factors in Engineering Success

Mr. Muller suggested five factors as being significant measures of engineering success. Earned prestige (not at the sacrifice of genuine humility) is one real measure of engineering success. Through contributions to the technical literature, inventions, and work as a professional executive an engineer can earn cherished professional prestige.

Financial success is another yardstick of engineering success. While we do not condone keeping up with the Joneses, it is necessary to stay in the same general social circle.

H. N. Muller, Jr., Mem. ASME, explains that an individual is the only one really qualified to determine his own success, at Junior Session of the 1954 ASME Semi-Annual Meeting, Pittsburgh, Pa., June 22.

Power is a by-product of financial success and earned prestige. As such it may be a measure of an engineer's accomplishments. The position of power is the motivating force for only a small percentage of our engineering ranks. It is mostly a collateral gain.

The individual's contribution to society is another measure of his success. His accomplishment, measured in terms of permanent advancements and improvement of mankind, as differentiated from convenience services, gives his life real value.

Although each of the four previous points are important measures of success, probably the most meaningful measure as far as the individual is concerned is inner contentment. The senior engineer, in reviewing his career asks the question "What did I want from my engineering career and did I find it?" We only live once and we must get the most out of it. Contentment can only be achieved if the individual is intensely interested in his work and has a well-balanced philosophy.

Old Guard Guests

As at several other recent national Society meetings, the "Old Guard" made financial arrangements for an outstanding young Associate Member of each of ten sections in the Pittsburgh area to attend the meeting. Almost without exception the young men present at the meeting—and some of the older ones, felt that the subject was presented in such a way that it would be of considerable aid in planning their careers. Guests of the Old Guard, many of whom contributed to the formal discussion following Mr. Muller's talk, were: Clair Leonard, Youngstown Section; R. W. Wixom, Akron; Kilborn Church, Cleveland; John Reber, Jr., Susquehanna; Robert Smith, Columbus; C. F. Simon, Jr., Erie; Ralph Yohn, Central Pennsylvania; J. Fletcher Osterle, Pittsburgh; G. W. Anderson, Canton-Alliance-Massillon; and Dennis Jones, Westmoreland.

Discussion Brings Out Interesting Ideas

In all, some 16 persons contributed to the interesting and worth-while formal discussion. These included Lewis K. Sillcox, ASME President; F. S. Blackall, jr., ASME past-president; Crosby Field, president, Flakice Corporation; H. O. Semler, Pittsburgh; J. C. Somers, Long Island, N. Y.; Peter Stein, Boston, Mass.; Kurt H. Strauss, Beacon, N. Y.; W. T. Williams, Minneapolis, Minn.; R. W. Ulbrich, Pittsburgh; R. A. Cederberg, chairman, Pittsburgh; and J. E. Harder, vice-chairman, Pittsburgh. Actively participating guests of the Old Guard were Messrs. Leonard, Smith, Simon, Anderson, Jones, Church, and Wixom.

Mr. Sillcox pointed out that in a real sense, a success is a great person with a great message.

Mr. Field stressed the importance of a philosophy of life. In one's religion and from the inspiration of the great masters of painting, prose, and poetry one finds great aid to a perspective in life.

Mr. Blackall discussed a number of points of interest to the group. The general theme of his comments was to point out the importance of individual initiative. "The guy who never does more than he gets paid for never gets paid

[1] Educational Center, Westinghouse Electric Corporation, Pittsburgh, Pa. Assoc. Mem. ASME.

[2] Trainee, Westinghouse Electric Corporation, East Pittsburgh, Pa. Assoc. Mem. ASME.

for more than he does." Engineers should be broad-minded and open-minded. They can make a real contribution to any phase of a corporation's activity. Engineers who have ideas about the ASME and its activities should make them known.

Mr. Blackall pointed out with respect to the question of unionization of engineers that the ASME is a professional organization and will not fight (or support) unionization.

One thought it a good idea to pick one day of the year for a personal inventory—to evaluate what benefit you have been to your employer, your family, your society, and yourself during the past year. He said that he had found evaluating changes that occurred during the past year to be of material assistance in planning for the future.

Other discussers alluded to personal versus group success and the relationship of professionalism and unionism as it affects the individual engineer's success. The general sentiment of the group was that there is some correlation between group success and the success of the individual, but the union did not particularly enhance the possibilities of individual success.

A prolonged informal discussion following the session and many complimentary remarks through the balance of the Semi-Annual Meeting were witness to the fact that this was an interesting and successful meeting.

Plans for the Fall Meeting, Milwaukee

The National Junior Committee will sponsor a session of interest to all engineers and especially to young engineers at the Milwaukee Fall Meeting. This session will be held on Wednesday, Sept. 8, 1954, at 2:30 p.m.

R. C. Panlener, director of industrial relations, college of engineering, Marquette University, will speak on "How Engineering Has Made Milwaukee an Important Manufacturing Center." The meeting will be opened to discussion following the talk.

J. J. Noble of Container Corporation of America is chairman of the session; G. F. Leitner of Cleaver-Brooks Company, vice-chairman.

Nine ASME sections are sending Associate Members to the meeting as guests of the Old Guard. They are G. F. Leitner, Milwaukee; T. R. Menary, Rock River Valley; J. Hill, Minnesota; B. Sturdevant, Iowa-Illinois; T. H. Gluck, Chicago; J. A. Foster, Jr., St. Joseph Valley; J. W. Lannert, Central Iowa; L. E. Staak, Fort Wayne; and R. Airgood, Central Indiana.

Returning Exhibitors Augment Power Show

Exhibitors at the 21st National Exposition of Power and Mechanical Engineering at Philadelphia, Pa., will include, in addition to many newcomers, a number of companies returning after absences from recent events. The rising total will equal or exceed the 1952 display. The scheduled dates, Thursday, Friday, and Saturday, December 2, 3, and 4; and Monday and Tuesday, December 6 and 7, were arranged during the period of the seventy-fourth Annual Meeting of The American Society of Mechanical Engineers, under whose auspices the exposition will again be held.

Exhibits already located in the exposition comprise the entire field of power-plant engineering and associated mechanical apparatus, from the cold fuel through to the turning shaft, even to the final application of power to the productive machine, whatever it may be. There will be displays by producers and fabricators of raw materials in great variety; boilers and steam generators; gas and oil burners; auxiliaries representing every avenue of economy in the production of steam for processing, as well as for power purposes. The range includes a long list of mechanical and electrical drives and transmissions, material-handling equipment of every description, piping, valves, and controls.

Instrumentation will reach new peaks of interest for visitors through the latest developments in automation. Equipment for research is keeping step with the exotic demands of the atomic age, as power-plant engineering advances from steam to the internal-combustion turbine and reaches toward the atomic power plant of the future.

Advances that will permit new theory and design to reach reality center on materials increasingly resistant to extreme temperatures and pressures, and even more so, increasingly resistant to wear and corrosion. New materials and their applications will therefore highlight the exposition, up to the limit of permissible disclosure; for many exhibitors are moving rapidly ahead in classified areas, whose impending impact may only be surmised.

Philadelphia's great Commercial Museum, where the exposition will be held, has the advantage that all spaces are on the ground level, with complete facilities for electrical and mechanical services, and ample access for rapidly handling materials in and out.

As heretofore, the exposition will be under the management of the International Exposition Company, with headquarters at 480 Lexington Avenue, New York, N. Y. E. K. Stevens is the exposition manager.

Automatic Control, Automation, Control Engineering

An Index of technical papers on automatic control, automation, control engineering published by The American Society of Mechanical Engineers during the past sixty-three years was recently compiled.

The six-page mimeographed list covers the periods from 1891 to 1949 and 1950 to 1954. The index would prove an invaluable aid to engineers, researchers, and designers since it traces important information in the field of automation from its very inception to its present-day far-reaching manifestations and acceptance in many fields of engineering.

The index of more than 150 titles includes a reference to automatic-control terms (1946) and to papers by James McBride (1891); R. J. S. Pigott; T. A. Peebles; Potter, Solberg, and Hawkins; Mason and Philbrick; J. C. Peters; and Ziegler and Nichols among many others.

The index (but not the original papers) is available upon request from the ASME Publications Office, 29 West 39th Street, New York 18, N. Y.

ASME Calendar of Coming Events

Sept. 8–10
ASME Fall Meeting, Hotel Schroeder, Milwaukee, Wis.
(Final date for submitting papers was May 1, 1954)

Sept. 13–24
ASME Instruments and Regulators Division and Instrument Society of America Exhibit and Joint Conference, Commercial Museum and Convention Hall, Philadelphia, Pa.
(Final date for submitting papers was May 1, 1954)

Sept. 26–29
ASME Petroleum Mechanical Engineering Conference, Hotel Statler, Los Angeles, Calif.
(Final date for submitting papers was May 1, 1954)

Oct. 28–29
ASME-AIME Joint Fuels Conference, William Penn Hotel, Pittsburgh, Pa.
(Final date for submitting papers was June 1, 1954)

Nov. 28–Dec. 3
ASME Annual Meeting, Statler Hotel, New York, N. Y.
(Final date for submitting papers was July 1, 1954)

Feb. 16, 1955
The Founding Anniversary Meeting, McGraw-Hill Building, New York, N. Y.
(No formal papers will be presented)

March 23–24, 1955
ASME Management Conference, Hotel Statler, Cleveland, Ohio
(Final date for submitting papers—Nov. 1, 1954)

April 16, 1955
The Organization Anniversary Meeting, Stevens Institute of Technology, Hoboken, N. J.
(No formal papers will be presented)

April 18–21, 1955
Diamond Jubilee Spring Meeting, Lord Baltimore Hotel, Baltimore, Md.
(Final date for submitting papers—Dec. 1, 1954)

April 25–26, 1955
ASME Instruments and Regulators Conference, University of Michigan, Ann Arbor, Mich.
(Final date for submitting papers—Dec. 1, 1954)

June 5–10, 1955
ASME Oil and Gas Power Conference, Hotel Statler, Washington, D. C.
(Final date for submitting papers—Feb. 1, 1955)

June 15–17, 1955
ASME and The Institution of Mechanical Engineers, London, England, Joint Conference on Combustion, Massachusetts Institute of Technology, Cambridge, Mass.
(Final date for submitting invited papers—Nov. 1 1954)

June 19–23, 1955
Diamond Jubilee Semi-Annual Meeting, Hotel Statler, Boston, Mass.
(Final date for submitting papers—Feb. 1, 1955)

Sept. 12–16, 1955
ASME Instruments and Regulators Division and Instrument Society of America Exhibit and Joint Conference, Los Angeles, Calif.
(Final date for submitting papers—May 1, 1955)

Sept. 25–28, 1955
ASME Petroleum-Mechanical Engineering Conference, Jung Hotel, New Orleans, La.
(Final date for submitting papers—May 1, 1955)

Nov. 13–18, 1955
Diamond Jubilee Annual Meeting, Hotel Congress, Chicago, Ill.
(Final date for submitting papers—July 1, 1955)
(For Meetings of Other Societies, see page 783)

ASME Regional Administrative Committees Held Meetings in March, April, and May

1954 ASME Regional Delegates Discuss Society Affairs at Pittsburgh, June 20-21

RECOMMENDATIONS of the ASME Regional Delegates Conference, which met at the William Penn Hotel, Pittsburgh, Pa., June 20-21, during the 1954 ASME Semi-Annual Meeting, were reported to the Council at the conclusion of the Conference and have been referred to the appropriate ASME committees concerned for study and suggested action. After the committees have completed their studies and have reported on them, the Council will take action and prepare a report of the final disposition of each recommendation.

Through the Regional Delegates Conference, members of ASME have an opportunity to discuss Society affairs and have a voice in procedures which bring matters of importance to them to the attention of the Council in an orderly manner. Each conference elects an Agenda Committee whose duty it is to assemble from members and sections subjects and suggestions on which action is desired. These agenda items are discussed and acted upon at meetings of the eight Regional Administrative Committees, held in the spring, consisting of representatives of sections of each Region. Each Region sends two delegates, a senior and a junior delegate, to the conference held at the time of the Semi-Annual Meeting. Here the agenda items, which were approved by three or more of the eight RAC Meetings, are discussed by the delegates and the final recommendations are prepared for submission to the Council.

The speaker of the 1954 conference was John W. Little, Region IV; the vice-speaker, R. W. Worley, Region III; and C. W. Crawford of Region VIII was the secretary. Roll call of the delegates was made by Secretary Crawford and the delegates who were present are as follows (the first name given in each case is that of the senior delegate and the second, that of the junior delegate):

Region I:	D. A. Fisher and John P. Heumann
Region II:	Paul T. Onderdonk and W. L. Boswell
Region III:	R. W. Worley and Gardner M. Ketchum
Region IV:	John W. Little and D. A. Holden
Region V:	A. B. Heiberg and F. L. Schwartz
Region VI:	Robert D. Teece and A. K. Simons
Region VII:	Robert L. Johnson and William H. Swann
Region VIII:	C. W. Crawford and Allen H. Jensen

Region I, Storrs, Conn.

Region II, New York, N. Y.

Region III, Buffalo, N. Y.

Region V, Cleveland, Ohio

The 1954 Agenda Committee consisted of L. S. Whitson, chairman, C. C. Womack, Sr., and J. C. Jefferds, Jr. Chairman Whitson and Mr. Womack were in attendance at the conference. Speaker Little announced the following committees: Nominating Committee for 1955 officers: R. W. Worley, Region III, R. D. Teece, Region VI, D. A. Fisher, Region I. The Resolutions Committee consisted of A. B. Heiberg, Region V; P. T. Onderdonk, Region II; and R. L. Johnson, Region VII.

The following officers for the 1955 RDC meeting were elected in accordance with the recommendation of the Nominating Committee: Allen H. Jensen, speaker; John P. Heumann, vice-speaker; A. K. Simons, secretary; and John W. Little, Agenda Committee chairman.

Resolutions of thanks and appreciation were prepared by the Resolutions Committee and signed by A. B. Heiberg, P. T. Onderdonk, and R. L. Johnson.

Region VI, Milwaukee, Wis.

Region VII, Portland, Ore.

Region VIII, Tulsa, Okla.

ASME 1955 Nominating Committee Organizes

SELECTED at the 1954 Semi-Annual Business Meeting of The American Society of Mechanical Engineers, Pittsburgh, Pa., June 20–24, 1954, the 1955 National Nominating Committee at its organization meeting chose E. W. Allardt, The Babcock & Wilcox Company, Alliance, Ohio, as chairman and Roy C. Robertson, University of Tennessee, Knoxville, Tenn., as secretary.

Plans were made for a preliminary meeting of the committee at the 1954 Annual Meeting, New York, N. Y., at which arrangements will be made as to time and location of the executive meeting for nomination of the Society Officers for 1955.

The 1955 National Nominating Committee is composed of the following:

Region I. L. E. Seeley, College of Technology, University of New Hampshire, Durham, N. H.; Theodore N. Graser, *1st Alternate*, Cochrane Steam Specialty Company, 80 Federal St., Boston 10, Mass.; S. L. Grapnel, *2nd Alternate*, Belding-Heminway-Corticelli Company, Putnam, Conn.

Region II. Philip C. Osterman, American Gas Furnace Co., Spring and Lafayette Sts., Elizabeth, N. J.; A. T. Kniffen, *1st Alternate*, General Engineering Division, Air Reduction Company, Inc., 60 East 42nd St., New York 17, N. Y.; Henry F. J. Skarbek, *2nd Alternate*, American Aluminum Casting Company, 326 Coit St., Irvington, N. J.

Region III. Guerard Mackey, Engineering Department, E. I. du Pont de Nemours & Company, Inc., Wilmington 98, Del.; Joseph W. Putt, *1st Alternate*, Hahn Motors, Inc., Hamburg, Pa.; Sigmund Kopp, *2nd Alternate*, Alco Products Division, American Locomotive Company, Roberts Road, Dunkirk, N. Y.

Region IV. Roy C. Robertson, *secretary*, Mechanical-Engineering Department, University of Tennessee, Knoxville, Tenn.; Arthur Roberts, Jr., *1st Alternate*, Lynchburg Foundry Co., Lynchburg, Va.; A. D. Holland, *2nd Alternate*, Mechanical-Engineering Department, Georgia Institute of Technology, 225 N. Ave., Atlanta, Ga.

Region V. E. W. Allardt, *chairman*, Tubular Products Division, The Babcock & Wilcox Corporation, 640 E. Keystone St., Alliance, Ohio.; H. N. Muller, Jr., *1st Alternate*, Westinghouse Electric Corporation, 401 Liberty Ave., Box 2278, Gateway Center, Pittsburgh 30, Pa.; J. F. Cunningham, Jr., *2nd Alternate*, Midwest Equipment Company, 545 W. Broad St., Columbus 8, Ohio.

Region VI. J. G. Van Vleet, Mechanical-Engineering Dept., Milwaukee Extension, University of Wisconsin, 600 W. Kilbourn Ave., Milwaukee 3, Wis.; R. W. Mills, *1st Alternate*, Mechanical-Engineering Department, University of Nebraska, 108 Richards Laboratory, Lincoln, Neb.; Charles A. Davis, *2nd Alternate*, Deere & Company, 1325 Third Ave., Moline, Ill.

Region VII. Bertram G. Dick, Bonneville Power Administration, Department of Interior, Box 3537, Portland 8, Ore.; Harold A. Johnson, *1st Alternate*, Mechanical-Engineering Department, University of California,

Berkeley 4, Calif.; Donald S. Angell, *2nd Alternate*, Kaiser Aluminum and Chemical Corporation, Trentwood, Spokane, Wash.

Region VIII. Richard B. Stewart, Mechanical-Engineering Department, University of Colorado, Boulder, Colo.; H. B. Atherton, *1st Alternate*, Kansas City Power & Light Company, Postal Station "F," Kansas City 1, Mo.; R. W. Cox, *2nd Alternate*, Dallas Power & Light Company, 1506 Commerce St., Dallas 1, Texas.

AMF Presents Atomic Energy Plant Model to USIA

American Machine and Foundry Company presented to the United States Information Agency a model of a "packaged" atomic power plant. The model is part of a display of peaceful applications of the atom which is included in the United States exhibit, "Atoms for the Benefit of Mankind," at the São Paulo, Brazil, World's Fair, August 21 to January 25, 1955. Rodney C. Gott, executive vice-president of AMF, made the presentation to Richard L. Brecker, chief, exhibits branch of USIA, at a ceremony in the Waldorf-Astoria Hotel, New York, N. Y., July 13, attended by officials of the Brazilian government including Dr. Francesco Medaglia, commercial attaché of the Brazilian Embassy and director of the Brazilian Government Trade Bureau, and professional, research, and educational institution representatives.

The AMF exhibit shows the application of a packaged atomic power plant, whose components are ready for assembly and can be transported into a remote area, to supply heat, power, and light, in this instance, to an entire mining community in an inaccessible area of Brazil to which power otherwise would not be available.

Ten ft long, eight ft high, and four ft deep, the exhibit features a one-twenty-fourth scale model of an atomic power reactor, a full-color diorama scene of the area in question, and color transparencies of certain phases of the operation.

Mr. Brecker called the exhibit an excellent example of private industry's co-operation in support of President Eisenhower's United Nations speech on December 8, 1953, in which he called for international co-operation for peaceful use of atomic energy. USIA plans similar exhibits this year which will tour Europe, India, Pakistan, and Arabian and Middle Eastern areas.

Actively engaged in atomic energy development since the earliest days of the U. S. Atomic Energy program, AMF has developed, designed, and manufactured a variety of special atomic energy equipment. The company is engaged in contract work on reactor equipment and reactor-systems design for the Atomic Energy Commission, its contractors and private firms working to develop economic nuclear power. In addition to research reactor development, AMF's own atomic energy program includes development and engineering of reactor equipment and package atomic power plants.

AEC Selects West Coast Industrial Information Depository

Stanford Research Institute, Menlo Park, Calif., has been selected as an Atomic Energy Industrial Information Depository to serve the West Coast area.

Stanford Research is the third such depository named by the AEC. Others are the Atomic Industrial Forum, New York, N. Y., and the John Crerar Library, Chicago, Ill.

Policies on ASME Budget for 1954—1955

The following statement of policies with the schedule of income and expense constitutes the Budget for 1954–1955.

1 A continuous effort will be made to collect dues.

2 No appropriation shall be made by Council without first referring back to the Finance Committee for recommendation. When a liability is assumed the means for paying for it shall be provided in advance.

3 No new activity shall be undertaken without definitely showing that the funds required to support it will be available without decreasing the appropriations for existing essential activities, giving the consideration to the administrative expense that may be involved. When a new activity is authorized, if the additional funds to support it are not directly available from the unappropriated income, Council shall say what activity shall be curtailed or suppressed to permit transference of the fund required to support the new activity. If the budget of expenses is to be reduced, the Council shall say what activity shall be curtailed or suppressed.

4 The Society shall hold four general meetings with expense chargeable to the budget. A fee shall be charged to nonmembers for admission to general or technical sessions at the four meetings of the Society according to rules established by the Board on Technology. No payments will be made for rental of rooms for the holding of technical sessions.

5 Council meetings shall be held at the place and time of the Annual and Semi-Annual Meetings. Council representation within the budget shall be provided for the other national meetings.

6 Within the allowance of the budget, Vice-Presidents shall be expected to visit Sections and Student Branches and attend Student Branch Conferences in their Regions or arrange for visits by their representatives.

7 No travel allowance will be provided for Board and Committee Chairmen attending Council Meetings except upon special provision of Council or the Executive Committee.

8 Eight Regional Administrative Committee meetings will be held.

9 A Regional Delegates Conference will be held at the place of the Semi-Annual Meeting.

10 The Nominating Committee may hold a preliminary meeting at a place to be selected and a Selection Meeting at the Semi-Annual Meeting within the provisions of the budget.

11 The following uniform basis of contri-

"Packaged" Atomic Power-Plant Exhibit by American Machine & Foundry Company for use as an integral part of the United States' "Atoms for the Benefit of Mankind" exhibit at the São Paulo (Brazil) World's Fair, Aug. 21 to Jan. 25, 1955, was turned over by R. C. Gott, *left*, executive vice-president of AMF, to R. L. Brecker, chief, exhibits branch, United States Information Agency, as Dr. Francesco Medaglia, commercial attache of the Brazilian Embassy and director of the Brazilian Government Trade Bureau, looks on. Presentation was made in New York, N. Y., July 13, at the Waldorf-Astoria Hotel. A large audience attended the ceremony.

bution toward travel expense shall be adopted.

For meetings of the Council, the Vice-Presidents (when meeting at some other time and place than the Council), the Nominating Committee, the Regional Administrative Committees, and the Regional Delegates Conference:

For Transportation By Rail—Full railroad fare including Pullman (not to exceed roomette rate) plus government tax; *Air*—Airplane fare plus government tax; and *Automobile*—Six cents per speedometer mile for the car used except that the amount shall not exceed railroad first-class fare.

For Time on Travel—$6 per day for each day or major part thereof of actual time on travel on trips of 100 miles or more (not to exceed travel time by standard railroad route).

For Time at Meeting—$6 per day for the days or major parts thereof required for the business of the stated meeting. This payment is not made to a member who resides at or near the place of meeting unless lodging away from home is required.

These payments will be made upon submission of a report on a form supplied by the Secretary.

For Student Branch Conference—20 cents per mile for each Student Branch Delegation, including the honorary chairman. Student delegations under this provision may consist of (*a*) the honorary chairman, (*b*) the honorary chairman and at least one student delegate, or (*c*) one or more student delegates.

Visits of Presidents and Vice-Presidents or their designated representatives to Sections, Branches, etc.—out-of-pocket expense within budgetary limits prescribed.

12 Payments to the Sections for Operation shall be on the basis of the Standard Formula plus 25 per cent.

The Standard Formula is: $3.50 per member for the first 75 members, $1.50 per member for the next 425, $1.25 per member for the next 500, $1 per member for all over 1000, and $150 to each Section for each authorized Subsection.

Supplementary payments equal to one third of a dollar for each paid-up member in the Section on September 30, this supplementary payment to be made only on a specific request from the Section showing necessity for it, and with the approval of the Vice-President, the additional payment to be made with the second payment to the Section.

Any payments to a Section in addition to those paid on the Standard Formula shall require authorization by the Council.

Payments by the Section shall be made in accord with the Sections Operation Manual, and the Secretary's Staff has authority to deny reimbursement for payments not so made.

(*Continued on page 792*)

COMBINED ANALYSIS OF EXPENDITURE BUDGET 1954–1955

Under Committee Supervision

	Direct Expenditures	Joint Bodies	Members' Travel	Printing and Distribution	Office Expense	Total
PUBLICATIONS, STANDARDS, CODES, AND RESEARCH						
MECHANICAL ENGINEERING text pages (excluding student copies)				$110,000.00	$ 53,042.00	$ 163,042.00
MECHANICAL ENGINEERING advertising pages (excluding student pages)				157,100.00	134,687.00	291,787.00
Transactions (including *Journal of Applied Mechanics*)	$ 1,100.00			11,300.00	48,332.00	60,732.00
Membership List				7,000.00		7,000.00
"Know Your Society" (organization charts)				1,000.00		1,000.00
ASME Catalog				51,000.00	37,995.00	88,995.00
Publication sales (except standards, codes, and research reports)				93,000.00	20,732.00	113,732.00
Standards and Codes		$ 1,000.00		85,000.00	94,351.00	180,351.00
Research				7,000.00	19,281.00	26,281.00
GENERAL SOCIETY ACTIVITIES						
Society meetings (including publicity)	57,000.00				16,107.00	73,107.00
Sections (including Regional Administration Committee of Regional Delegates Conference)	85,000.00		$20,000.00		23,020.00	128,020.00
Professional Divisions	15,000.00				22,505.00	37,505.00
Student Branches (including copies of MECHANICAL ENGINEERING text and advertising pages)	9,500.00		6,500.00	32,700.00	10,446.00	59,146.00
Admissions					24,323.00	24,323.00
Development					9,101.00	9,101.00
Awards	1,200.00				1,370.00	2,570.00
Engineers Civic Responsibility	500.00					500.00
Lectureships	2,000.00					2,000.00
GENERAL SOCIETY ADMINISTRATION						
Council	2,800.00		9,000.00			11,800.00
Professional Services (auditors, counsel, etc.)	5,500.00					5,500.00
Nominating Committee			2,500.00			2,500.00
Retirement Fund	58,000.00					58,000.00
JOINT ACTIVITIES						
Engineering Societies Library		16,400.00				16,400.00
Engineers' Council for Professional Development		2,340.00				2,340.00
Engineers Joint Council		7,500.00	300.00			7,800.00
Engineering Societies Personnel Service, Inc. (reserve)		500.00				500.00
Registration (National Council of State Boards of Engineering Examiners)		500.00				500.00
UET Pension Fund		3,700.00				3,700.00
National Management Council		500.00				500.00
INDIRECT EXPENSE						
Secretary's office					81,044.00	81,044.00
Accounting department					55,134.00	55,134.00
General service (stores, mailing, filing, etc.)					105,376.00	105,376.00
General Office (rent, insurance, etc.)					64,279.00	64,279.00
TOTAL	$237,600.00	$32,440.00	$38,300.00	$555,100.00	$821,125.00	$1,684,565.00

13 Grants of Society funds for Section, Division, and Student Branch operations shall not be used for social events.

14 The Society shall have two representatives on the American Standards Association.

15 No publications shall be printed for sale unless there is reasonable assurance of sufficient orders to pay for the cost.

Engineering Societies Personnel Service, Inc.

THESE items are from information furnished by the Engineering Societies Personnel Service, Inc., in co-operation with the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to all engineers, members, or nonmembers and is operated on a nonprofit basis.

In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrant members whose availability notices appear in these columns. Apply by letter, addressed to the key number indicated, and mail to the New York office.

When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available at a subscription of $3.50 per quarter or $12 per annum for members, $4.50 per quarter for nonmembers, payable in advance.

New York	Chicago	Detroit	San Francisco
8 West 40th St.	84 East Randolph St.	100 Farnsworth Ave.	57 Post St.

Men Available[1]

Mechanical Engineer, 36; seven years' experience solving dust and fume problems in foundry, welding, and painting operations. Desires position as ventilation engineer with consulting firm. Me-110.

Management Engineer, IE, desires work in cost reduction, production planning, flexible budget control, profit planning, standard costs, work simplification, systems and procedures; 30 years' diversified experience. Will relocate. Me-111-905-Chicago.

Mechanical Engineer, 37; diversified experience in design of industrial and chemical plants. Desires position with consulting engineers or plant-engineering department, industrial or chemical concern, in metropolitan New York. Me-112.

Mechanical Engineer, 46; married; mechanical graduate; 17 years' varied experience in aircraft, mechanical equipment of buildings, heating, ventilating, plumbing design, construction planning; administrative experience and ability. Registered in Mo. and N. Mex. Me-113-SF-2-2-San Francisco.

Manufacturing Manager, 39; experience includes cost reduction, quality control, time study, methods, production planning, and plant engineering in foundry, machining, and assembly operations. At present handling metal-manufacturing plant involving 1500 employees. Me-114.

Construction Engineer, BSEE, BSME; 30; married; veteran; ten years' diversified experience in supervision, inspection of construction, and maintenance; circuit analysis, motor control, power distribution, system planning, plant layout, power plant, machinery installation, equipment testing, and handling personnel. Fluent Spanish and knowledge of Italian, Portuguese, and French. Me-115.

Mechanical Engineer, BME, 38; registered PE, 20 years' heavy machinery background in administration, supervision, and design; good coordinator; broad design experience on hydraulic, conveyerized, and other types of heavy equipment. Me-116.

Director, MS (ME); 20 years' intensive and varied experience in research, engineering, and development; particularly skilled in building organizations, personnel, facilities, and new products; past six years at management levels. Me-117.

Mechanical Engineer, 33; BSME; registered PE; ten years' diversified experience designing gears, turbines, weldments, special machinery, tools and fixtures, and machine-shop practice. Desires project engineering position in New York, N. Y. Me-118.

[1] All men listed hold some form of ASME membership.

Positions Available

Industrial Engineer, 26–35, industrial or mechanical engineering graduate, for plant layout, process, flow, materials-handling, and cost analysis covering manufacturing in leather, textiles, rubber, or allied products field. Some traveling to foreign plants. $6000–$8000. Md. W-123.

Chief Engineer, 40–45, ME degree, to take charge of entire engineering program, directly responsible for research and development, for a manufacturer of machine tools. Will act in an advisory and consulting capacity to all branches of engineering. $20,000–$25,000, plus bonus. New England. W-159.

Technical Research Director, 38–50, preferably PhD, must have at least ten years' experience in vinyl and thermo plastics, including extrusion. Should also have good management experience. $15,000. New York, N. Y. W-195.

Managers. (*a*) Manager, field sales and service, 35–40, degree in engineering and/or business administration. Will conduct the field sales and service activities for electronics-equipment division of larger operation. Experience in electronics, electrical, or allied fields serving industrial markets, required. $12,000–$15,000 (plus performance bonus). New England. (*b*) Manager, district-sales office, 32–38, degree in engineering and/or business administration. Will conduct sales and service activities. Should have experience in electronics, electrical, or allied fields serving industrial markets. Must have actual selling plus at least a minimum of sales management or administration. $8000–$11,000 (plus performance bonus). Midwest. W-217.

Production Manager, at least ten years' light-metal manufacturing and plating experience covering electromechanical components and radio hardware. $10,000–$12,000. N. H. W-226.

Works Manager—Chief Engineer, graduate mechanical, 35–50, for manufacturing company in steel and aluminum products. Should have heavy technical background in shearing, braking, welding, and assembly. Plant employs 300. $15,000–$18,000. Conn. W-245.

Mechanical Engineer, about 40, machine-shop manufacturing experience, at least ten years' experience in design and development of light machinery employing mechanical, electrical, hydraulic drives, and their controls. Some knowledge of electronics desirable. Position requires tact in co-ordinating engineering and shop activities; there is an opportunity for advancement into management. $9000–$12,000. Conn. W-269.

Chief Engineer, not over 50, to head up an engineering division, which includes research, production, design, and development, for a large manufacturer of consumer goods in the chemical, metallurgical, and electrical fields. To $25,000. Ohio. W-281.

Chief Engineer, graduate mechanical, to supervise five to ten engineers and draftsmen; the design work involves semicustom designing of heavy bakery machinery from sheet metal and structural-steel shapes. Must have a knowledge of processing of these materials; knowledge of the principles of heat-transfer and furnace operation. $8000–$10,000. Conn. W-284.

Engineering Trainees. (*a*) Mechanical and/or chemical-engineering trainee, under 30, for foreign assignment with refining division of oil company. Will be trained in U. S. for 12-month period prior to foreign assignment. While training, $4500. (*b*) Mechanical-engineering trainee for lubrication and product procurement for major oil comany. Training assignment indefinite in U. S. Should be prepared for ultimate overseas assignment. While in training, $375–$400 a month. Temporary location, New York, N. Y. W-285.

Engineers. (*a*) Mechanical engineer, not over 32, draft exempt, for position involving planning, scheduling of current construction, and forecasting of future projects, establishing work priorities, reviewing construction-material status, maintaining job-status reports. Producing operation assignment. Two-year contract with 3½ months' vacation. $6000–$9000, depending on qualifications; salary paid in American currency. Room and board furnished for single applicants; if married, after a period of approximately ten months, will be given residence allowance for quarters and living. Foreign. (*b*) Project or process engineer, not over 45, oil-refinery experience, for foreign assignment. Salary open. Far East. F-286.

Engineers. (*a*) Cost-estimating manager, to provide estimates of manufacturing costs, when required by the sales department, which are reliably co-ordinated with actual manufacturing costs. Should have several years' actual experience in cost estimating in a responsible capacity, with relations with sales, design engineering, and process or industrial engineers; practical knowledge of working with time-study engineers and of the development and use of standard data; some experience in process-engineering work. Salary open. (*b*) Standards engineering manager to administer and guide group working on the development of standard data to reduce work required in setting standards and to improve estimating. Will be responsible for providing and maintaining sound standards as required for the most effective administration of the factory-incentive and cost-accounting systems. Should have a minimum of five years' experience in working with time-study and standard of data; actual experience in a supervisory position over-time study and standard-data crews; experience in maintaining standards for incentive-bonus plan for shop personnel; previous experience in metal fabricating involving forming and welding on both a job-shop and production basis. Salary open. Pa. W-293.

Engineers. (*a*) Engineering trainee, recent graduate mechanical engineer, for foreign assignment in plant engineering after 18 months' training in U. S. $4200–$4800. (*b*) Technical trainee, with two to three years' experience; not over 30, for product-quality control and product development. Training period, two or three months in U. S. While training, $4800. W-296.

Instructor, young, for mechanical-engineering department; must have some experience in the field of industrial engineering and be in a position to teach subjects in that field. Midwest. W-308.

Engineers. (*a*) Technical director, to develop sales and educational program for the use of chemical service to poultry-feed manufacturers. Will also give lectures and write bulletins and maintain contact with poultry pathologist. (*b*) Technical representative, to develop sales and educational programs for chemical service to food manufacturers, that is, for preserving fruits and vegetables, as well as to other food-processing industries. $7800–$10,000. New York, N. Y. W-311.

Plant-Layout Engineer, mechanical graduate, young, three to four years' experience in mechanical layout of plant equipment, for small company manufacturing limestone products. Will work into maintenance. Some experience in a cement plant would be helpful. $4800–$6000, with opportunity for advancement. New England. W-314.

Chief Industrial Engineer, who has had broad experience and exceptional ability in various fields of industry, to direct a program of industrial development in an ancient country rich in natural resources. Will supervise and direct necessary investigation of raw process materials; evaluate cost and adequacy of fuel, water, power, and transportation required and ability of local markets to profitably absorb manufactured products; supervise and direct economic study and justification, design specifications, bid proposals, and evalua-

(*ASME News continued on page 794*)

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tion, contract negotiations, etc., construction, and operation of industrial plants and facilities. Duration, minimum of one year. Salary, related to past earnings, ranges from $14,400–$18,000, plus cost-of-living allowance. Transportation provided. Far East. F-325.

Supervisor of Industrial Engineering, 35–45, mechanical or industrial-engineering graduate, time study, methods, and considerable wage-incentive experience in metal-products and coil-winding fields, to supervise time study, methods tooling, costs, and incentives for electrical-equipment manufacturer. $6000–$8000. Conn. W-341.

Designer, commercial kitchens, at least two years' experience in kitchen design and layout of equipment and estimating; knowledge of flow in large kitchens desirable. Duties will include handling and supervision of all kitchen layouts, development and research work, specifications writing, engineering correspondence, etc. $5000–$6000. Employer will negotiate fee. Ill. C-2062.

Engineers. (*a*) Junior process engineer, industrial or mechanical, to 30, with one to four years' experience in methods or plant-layout work in manufacturing (heavy industry helpful). Work will include tooling, jigs and fixture design, some drafting, cost control, standards, material handling, and some production scheduling. Recent graduates considered. Company will negotiate moving expenses and placement fee. $4800–$6000. Tenn. (*b*) Process engineer, industrial or mechanical, up to 32, four or five years' experience in methods and standards work in heavy industry with time-study base, for methods, standards, and cost work on locomotive repairs. Employer will negotiate fee. To $6600. Washington, D. C. C-2065.

Project Engineer, graduate mechanical or agricultural, at least ten years' experience in design and development, for project engineering and administrative work on design and development of all types of farm equipment such as mowers, rakes, balers, fertilizer spreaders, etc. Up to $10,000. Ohio. C-2067 (*a*).

Product-Sales Manager, 30–40, at least five years' experience in sale of steel stampings or fabrications on contract basis and two years' sales-supervisory background, for supervising contract sales of steel stampings to automotive and appliance manufacturers; and steel cabinets, jet-engine components, basic wheels, mufflers, and fuel tanks sold to defense industries. $8000–$10,000. Ohio. C-2079.

Applied Research Engineer, mechanical or chemical preferred. Good background in higher mathematics and physics or some experience in allied research work, to give over-all direction to the more fundamental applied research projects of the company. These projects would be in the fields of heat transfer, refrigeration, air conditioning, and air handling. Work to be performed in newly constructed research and testing laboratory. Salary open. Wis. C-2088 (*a*).

Project Engineer, mechanical, to 45, at least three years' experience in project work on fast-moving machinery such as packaging or paper-folding equipment; knowledge of printing helpful. Work will include project work in design, maintenance, and installation of very fast-moving, light-automatic machinery. Up to $8000. Employer will negotiate fee. Ill. C-2091.

Sales-Engineering Trainee, degree, 25–29, some knowledge of industrial machinery, to sell complete lubricating program to industrials covering full line of petroleum products, deal wih top management for most part. $4800–$5400. Employer will negotiate fee. Chicago, Ill. C-2095.

Designer, mechanical, up to 50, at least three years' experience in designing small mechanisms, such as cameras, typewriters, etc. Knowledge of projectors helpful for work in product design of projectors and allied equipment. $6500–$9100. Ill. C-2122.

Candidates for Membership and Transfer in the ASME

THE application of each of the candidates listed below is to be voted on after Sept. 24, 1954, provided no objection thereto is made before that date and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the Secretary of The American Society of Mechanical Engineers immediately.

Key to Abbreviation

R = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member

New Applications

For Member, Associate Member, or Affiliate

ALI, MIR MOHAMMED, Dacca, E. Pakistan
ANDERSON, JAMES T., East Lansing, Mich.
ATTAS, JACK E., Montreal, P. Q., Can.
BENNETT, WAYNE, Peekskill, N. Y.
BIRDSALL, ROBERT F., Wayne, Mich.
BLAKESLEE, DORAP W., Pittsburgh, Pa.
BRADLEY, WILLIAM B., Miami, Fla.
BROCHIERO, JUAN A., Viente Lopez, Argentina
BURNHAM, DONALD C., Pittsburgh, Pa.
BURROUGHS, EDWIN E., Pensacola, Fla.
CAMPBELL, WILLIAM R., JR., Wilmington, Del.
CARRELL, RAMSEY D., Terrell, Texas
CARY, ARTHUR F., Surry, Maine
CLUTE, JASPER L., Matthews, N. C.
COLLINS, ROBERT V., Detroit, Mich.
COMO, EDWARD W., Prides Crossing, Mass.
COMPTON, FRANK A., JR., Erie Pa.
DE MILIA, JOSEPH, Washington, D. C.
DESERIO, JOSEPH M., Cheektowaga, N. Y.
DILLINGER, EDWARD G., Portsmouth, Ohio
DODDS, WILLIAM D. G., Edinburgh, Scotland
DORRINO, ROBERT D., Whittier, Calif.
DREW, RICHARD E., Great Neck, N. Y.
DREWITZ, EDWIN W., Flushing, N. Y.
DURNAN, GORDON E., Toronto, Ont., Can.
EGGMANN, JEAN, Phillipsburg, N. J.
EPPRECHT, JOHN E., Boonton, N. J.
EVALDSON, RUNE L., Ann Arbor, Mich.
EZEKIEL, FREDDIE D., Cambridge, Mass.
FICKER, ARTHUR R., Fairfield, Ill.
FRIDAY, DONALD H., Aiken, S. C.
GARVEY, JAMES R., Columbus, Ohio
GRUB, CHESTER W., Fort Worth, Texas
GHAI, MADAN L., West Hartford, Conn.
GILE, KIRBY R., JR., San Francisco, Calif.
GITZENDANNER, LOUIS G., Scotia, N. Y.
HALL, CLYDE C., Decatur, Ala.
HALL, JOHN D., New Orleans, La.
HALTON, HARRY J., Los Angeles, Calif.
HANSON, ALBERT L., Woodbridge, N. J.
HARSHBERGER, CHARLES C., Portland, Ore.
HAZLETT, LOWELL D., Kansas City, Mo.
HELMKE, EDWARD C., Madison, Wis.
HOCKING, JAMES R., New York, N. Y.
IAGER, RAYMOND F., Alliance, Ohio
ISLAM, NURUDDIN T., Dacca, E. Pakistan
JACOBS, FOSTER, Levittown, L. I., N. Y.
JEYASINGH, ASIRVATHAM P., Madural, S. India
JONES, ELMER B., Springfield, Ohio
KAHN, WERNER, Rio de Janeiro, Brazil
KARR, MILTON, Los Angeles, Calif.
KENDY, LEONARD, Santa Monica, Calif.
KENISTON, HENRY E., Rocky Mount, N. C.
KHOKHAR, PREETAM S., Assam, India
KHOSLA, GAUTAM, Providence, R. I.
KNOLL, ALVIN H., Cincinnati, Ohio
KOLSTEE, HANS M., W. Springfield, Mass.
LAMOUREAUX, RAYMOND A., JR., North Adams, Mass.
LANGWORTHY, MERTON L., New York, N. Y.
LEVIEN, FREDERIC H., Bethlehem, Pa.
LEVY, JOSEPH, Pasadena, Calif.
LEVY, SOLOMON, Scotia, N. Y.
LITTLEWOOD, WILLIAM, St. Michaels, Md.
LOPEZ-SANCHEZ, ROBERTO A., Coyoacan, D. F., Mex.
LUDWIG, RICHARD E., South Bend, Ind.
LUNN, WALLACE E., Nashville, Tenn.
MEYER, URS K., Milwaukee, Wis.
MOLLICK, LEON, Brooklyn, N. Y.
MORALES, MARTIN J., Caracas, Venezuela, S. A.
MURRELL, FLOYD B., Lake Jackson, Texas
NAHM, WILLIAM H., Bedford, Ohio
NIELSEN, OSCAR, Roselle, N. J.
NORMAN, GEORGE C., Short Hills, N. J.
OLSON, RICHARD E., Hopkins, Minn.
O'ROURKE, WILLIAM F., Pendleton, Ore.
PATTISON, LEROY A., Whittier, Calif.
PAYNE, HERBERT M., Chattanooga, Tenn.
PEARSE, ROBERT G., Rumson, N. J.
PIERCE, RANSOM A., Pittsburg, Calif.
POSEY, ROBERT P., Honolulu, Hawaii, T. H.
PRUCE, PETER P., Los Angeles, Calif.
RATLIFF, THOMAS H., JR., Chester, Pa.
REICHENBACH, GEORGE S., Cambridge, Mass.
SANU, RAMON F., Oriente, Cuba
SHEARER, JAMES E., Cuyahoga Falls, Ohio
SHUPING, JESSE L., Downey, Calif.
SMITH, ALMONTIE C., Cocoa, Fla.
SMITH, FREDERICK H., Philadelphia, Pa.
SOBO, DAVID J., Los Angeles, Calif.
STUMP, LEE K., Kansas City, Mo.
THOMPSON, THEODORE O., Port Washington, Wis.
THOMPSON, WILLIAM E., Chicago, Ill.
TUCK, EDWARD F., Springfield, Mo.
URBAN, EDWARD M., Chicago, Ill.
VRKICH, STEVE J., Portland, Ore.
VENETUCCI, JIM M., Chicago, Ill.
WATERS, MARSHALL J., San Francisco, Calif.
WEIDENBRUCH, PETER P., Fond du Lac, Wis.
WILCOX, JOHN C., JR., Hackensack, N. J.
YOUNG, JOHN L., Beaver, Pa.
ZAUNER, JOHN H., Chicago, Ill.

Change in Grading

Transfers to Member, Associate Member, or Affiliate

ARNOLD, GRAYSON B., Los Angeles, Calif.
BESSENT, CARL F., Baltimore, Md.
CULPEPPER, RICHARD L., Chattanooga, Tenn.
FORD, ROBERT E., Lansing, Mich.
FORSBERG, ROY H., Canaga Park, Calif.
HARTWELL, ROBERT W., Grosse Ile, Mich.
LATIF, MOHAMMAD A., Rawalpindi, Pakistan
LIVERMORE, DONALD F., Madison, Wis.
WERTMAN, DAVID, Kensington, Md.

Transfers from Student Member to Associate Member 66

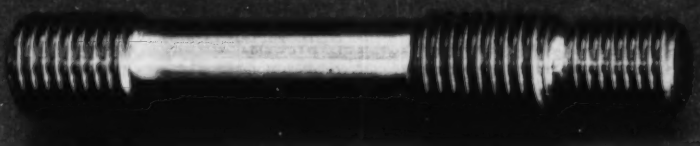
Obituaries . . .

Karl Taylor Compton (1887–1954), one of America's foremost physicists, a leading figure in the development of the atomic bomb, and chairman of the corporation of the Massachusetts Institute of Technology, died June 22, 1954. Born, Wooster, Ohio, Sept. 14, 1887. Parents, Elias and Otelia (Augspurger) Compton. Education, PhB, College of Wooster, 1908; MS, 1909; PhD, Princeton University, 1912; More than 30 honorary degrees were conferred on him in recognition of his brilliant contributions to science and education. Married Rowena Rayman, 1913 (deceased); daughter, Mary Evelyn (Mrs. Bissell) Alderman, Holyoke, Mass. Married 2nd, Margaret Hutchinson, 1920; children, Jean Corrin (Mrs. C. W.) Boyce, Scarsdale, N. Y.; Charles A., Northfield, Mass. Dr. Compton directed this country's scientific policy through a historic era that produced the atomic bomb, the variable-time fuse, and radar. As M.I.T.'s president from 1930 to 1949 he not only rearranged the curriculum to meet the needs of industry in a changing world, but also helped scientists on the campus to expand their laboratories and make headlines with the results of their research. He created a division of humanities with a view toward combining the precise knowledge of the professions with studies of broad human significance. When World War II began, he opened a radiation laboratory at M.I.T. He directed laboratory work that led directly to the production of $3 billion worth of radar equipment and other new weapons used by the Allies during the war. He received in 1946 the Medal of Merit—highest award that can be bestowed on a civilian by the United States Army—for "outstanding service" to his country. With it went a citation crediting him with being "personally responsible for hastening" the end of World War II. In October, 1948, President Truman appointed him to head the seven-man Research and Development Board of the National Military Establishment. The board reports directly to the Secretary of Defense on the highest-level, security-shrouded subjects. Dr. Compton, who served in 1946 as a member of the President's personal committee on atom-bomb tests, was one of the outstanding spokesmen for science in calling for co-operation with the United Nations. In 1948 he came out strongly in favor of universal military training and conscription, saying such measures would give this country a "stockpile of time" for an emergency. A year earlier he had served as chairman of the President's special commission that recommended compulsory training. He was a prolific writer on scientific subjects having published more than 200 papers on thermionics, electric emission from hot filaments, and spectroscopy. During the first World War he began his scientific research for the military when he served as an aeronautical engineer for the Army Signal Corps and also designed a sound detection device used in connection with his study of propulsion rockets. The detection devices were used to help in crushing Germany's vast submarine fleet. In 1918 he was associate scientific attaché at the American Embassy in Paris. Many awards for his research work were received by Dr. Compton, including the Rumford Medal, one of the world's most distinguished scientific honors; the first Procter Prize given by the Scientific Research Society of America; and the Hoover Medal. He was president of the American Association for the Advancement of Science from 1935 to 1936 and of the American Society for Engineering Education, 1938-1939. He had been a member of the Rockefeller Foundation, the Sloan-Kettering Institute for Cancer Research, and General Education Board since 1946; a member of the board of the Brookings Institution since 1940. One of his last public assignments was his election in April,

(*ASME News continued on page 796*)

Threading that's tough...or

Threading that's fussy...



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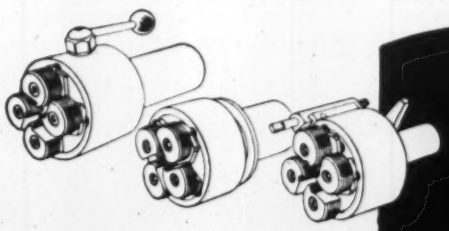
These are all Class 3 threaded parts from 347 stainless steel—special threads having rounded tops and bottoms and with 32 micro finish specified.

No every day jobs to handle, these pieces, because the work-hardening tendencies of the material under cutting pressures call for the right tools and special caution to maintain the class and finish demanded.

Plenty of shops experimented with various methods of thread chasing and grinding but it remained for Screw Products Company in Cleveland to lick the job. They are using standard Vers-o-tools for diameters to 1" with standard ground thread circular chasers and are "having no trouble at all".

Doesn't this suggest your inquiry on threading work, either tough and fussy jobs or run of mine? Catalog DT-52 will help.



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1954, as chairman of a 12-member New England committee set up to study the use of atomic energy for peacetime purposes in the Northeastern part of the country. He was a board member and trustee of many educational and industrial institutions. He is survived by his wife and three children; two brothers, Dr. Arthur H. Compton and Dr. Wilson M. Compton; a sister, Mrs. C. H. Rice; and five grandchildren.

Keep Your ASME Records Up to Date

ASME Secretary's office in New York depends on a master membership file to maintain contact with individual members. This file is referred to dozens of times every day as a source of information important to the Society and to the members involved. All other Society records and files are kept up to date by incorporating in them changes made in the master file.

From the master file are made the lists of members registered in the Professional Divisions. Many Divisions issue newsletters, notices of meetings, and other materials of specific interest to persons registered in these Divisions. If you wish to receive such information, you should be registered in the Divisions (no more than three) in which you are interested. Your membership card bears key letters opposite your address which indicate the Divisions in which you are registered. Consult the form on this page for the meaning of the letters. If you wish to change the Divisions in which you are registered, please notify the Secretary's office.

It is important to you and to the Society to be sure that your latest mailing address, business connection, and Professional Divisions' enrollment are correct. Please check whether you wish mail sent to home or office address.

For your convenience a form for reporting this information is printed on this page. Please use it to keep the master file up to date.

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Title of position held .....

Nature of work done .....

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Publication	*Address changes effective when received prior to:*
☐ Mechanical Engineering	10th of preceding month
☐ Transactions of the ASME	20th of preceding month
☐ *Journal of Applied Mechanics*	20th of preceding month
☐ *Applied Mechanics Reviews*	1st of preceding month

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☐ A—Aviation	☐ J—Metals Engineering	☐ S—Power
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☐ D—Materials Handling	☐ M—Production Engineering	☐ W—Wood Industries
☐ E—Oil and Gas Power	☐ N—Machine Design	☐ Y—Rubber and Plastics
☐ F—Fuels	☐ P—Petroleum	☐ Z—Instruments and Regulators
☐ G—Safety	☐ R—Railroad	
☐ H—Hydraulics		

Harry E. Corl (1892–1954), consulting engineer, Philadelphia, Pa., died April 18, 1954. Born, State College, Pa., Aug. 27, 1892. Parents, John C. and Emma S. Corl. Education, BS, Pennsylvania State College, 1914. Married Myrtle Gray, 1912. Assoc. Mem. ASME, 1922; Mem. ASME, 1935. Survived by wife and two children, Geraldine M. and James G. Corl. Assoc. Mem. ASME, Reidsville, N. C.

William Randolph Cosentini (1911–1954), partner, W. R. Cosentini and Associates, consulting engineers, New York, N. Y., died Jan. 28, 1954. Born, Brooklyn, N. Y., June 12, 1911. Parents Eugene and Vincenza (Vessichelli) Cosentini. Education, BS(ME), New York University, 1942. Married Rose De Stafano, 1944 (died 1947). Jun. ASME, 1942. Survived by two children, William E. and Mary Anne.

Manuel de Goirigolzarri y Arambalza (1879–1953), representative and nonexclusive surveyor in Havana, Cuba, for the American Bureau of Shipping, 1940–1948, died in February, 1953, according to a notice recently received at Society headquarters. Born, Urduliz, Vizcaya, Spain, June 17, 1879. Education, completed mechanical-engineering course, ICC. Assoc. ASME, 1918. Survived by wife.

Ross Earl Langill (1886–1954), secretary and treasurer, The Prescott Co., Menominee, Mich., died June 9, 1954. Born Wausau, Wis., Dec. 31, 1886. Education, graduate, Ferris Institute, Big Rapids, Mich., 1904. Mem. ASME, 1942. He held several patents pertaining to heavy sawmill and woodworking machinery.

Fred Viall Larkin (1883–1954), professor emeritus of mechanical engineering at Lehigh University, died May 23, 1954. Born, Verona, Wis., April 2, 1883. Parents Edwin N. and Eddora (Viall) Larkin. Education, BS, University of Wisconsin, 1906; MS, 1915; hon. DS, Stevens Institute of Technology, 1948. Married Nell Grant Wright, 1910. From 1927 until 1948, when he retired, he was director of curriculums in mechanical and industrial engineering at Lehigh University. He held two patents and was the author of several miscellaneous articles for the technical press. Mem. ASME, 1915; Fellow ASME, 1945. He served the Society as a member of Publication Committee, Council, and Committee on Relations With Colleges. Survived by wife and two sons, Franklin J. and Richard N.

Nathan M. Lower (1880–1954), who until his recent retirement was president-owner of Stoker Engineering and Manufacturing Co., Erie, Pa., died June 17, 1954. Born, Three Tuns, Pa., March 7, 1880. Parents, William C. and Mary P. (Marple) Lower. Education, BS, Pennsylvania State College, 1906. Married Edna E. Lautenslager, 1932. More than 300 patents were issued to him on his inventions relating to locomotive and industrial stokers. Mem. ASME, 1913. Survived by wife and a son, John L.

David McKnight McGinnis (1911–1954) president, Custom Engineering Co., Los Angeles, Calif., died Feb. 28, 1954. Born, East Ely, Nev., Nov. 5, 1911. Education, high-school graduate, 1929; engineering subjects at various evening schools in Los Angeles. He was commissioned by National Board of Boiler and Pressure Vessel Inspectors. Jun. ASME, 1944.

William A. Neill (1882–1954), retired mechanical engineer, died June 12, 1954. Born, Georgetown, Colo., March 17, 1882. Parents, Edward E. and Eva K. Neill. Education, public schools and ICC courses. Married Bertha E. Bleiber, 1903; daughter, Elizabeth B. Mem. ASME, 1918.

Jesse Taylor, Jr. (1892–1954), regional steam superintendent, Atlantic Region, Westinghouse Electric Corp., Philadelphia, Pa., died March 18, 1954. Born, Philadelphia, Pa., Oct. 17, 1892. Parents, Jesse and Mary Taylor. Education, public schools; courses in steam engineering. Married Linda Esther Gorman, 1919; children, Robert G. and Jesse, 3rd. Mem. ASME, 1940.

Henry Elwynne Worcester (1875–1954), retired vice-president, United Fruit Co. and Revere Sugar Refinery, Boston, Mass., and officer of several other companies, died April 9, 1954. Born, Lowell, Mass., Sept. 30, 1875. Parents, Horatio E. and Annie (Jaroce) Worcester. Education, graduate Lowell High School; 3 years, Massachusetts Institute of Technology, 1893–1896. Married Alice Gerry Duncan, 1905. Assoc. ASME, 1903. Survived by wife and three children, Mrs. Mary von Rosenvinge and John D., all of Winchester, Mass.; and Henry E., Annapolis, Md.

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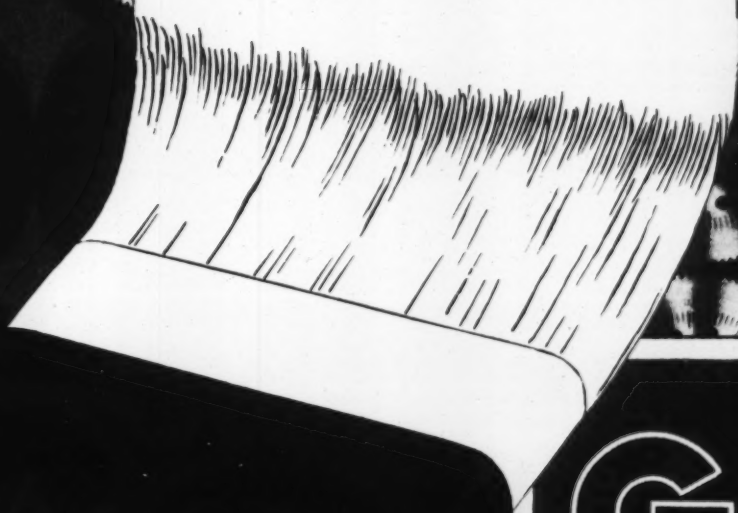

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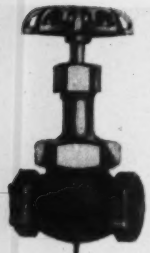
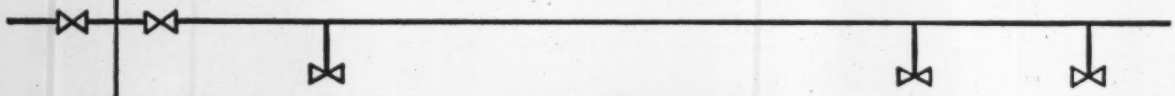


This "Hospital Valve" for **OXYGEN** now serves many industrial needs . . .

JENKINS Fig. 504 Bronze Globe with **TEFLON** disc and packing



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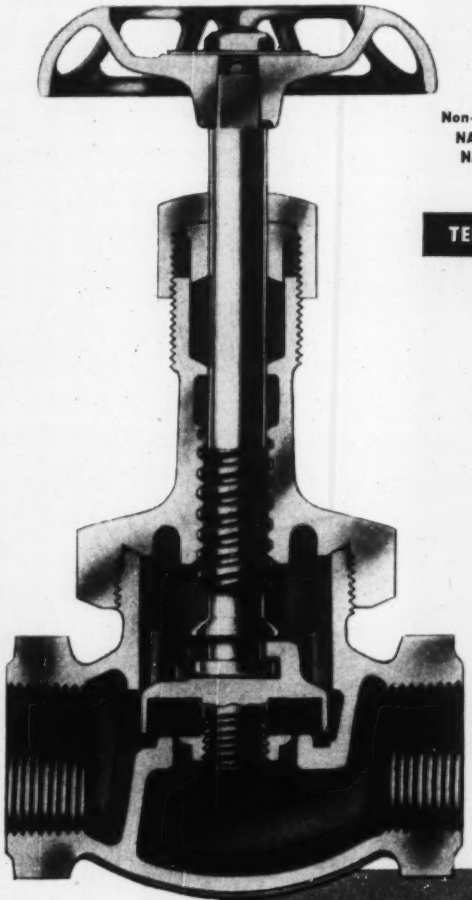

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High strength bronze body is ribbed along bottom centerline providing extremely high factor of safety. Guards against distortion from vibration, shock, or pipe strains.

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Alloy bronze spindle is polished to permit easy turning and assure leak-proof seal.

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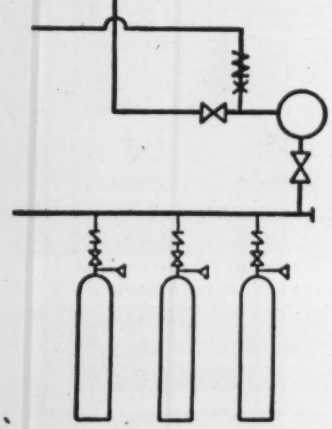

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Proportioning Pump

A new proportioning pump with no packing, but with unique high speed valves and pulse free flow is being introduced by Hills-McCanna Co., 3025 N. Western Ave., Chicago 18, Ill. Designated as the Hills-McCanna-Meter the pump is a packless, positive displacement, fully enclosed unit. Its design makes possible a wide output flow range which is easily adjustable by light finger pressure while the pump is operating or stationary.

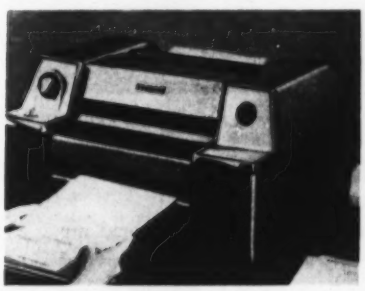
It is claimed the meter will precisely meter quantities from 5 cc to 6 gph per feed, dependent on material being handled. Under actual operating conditions, however, the pump has handled quantities as low as 3 cc per hour with good consistency and ability to reproduce the flow. Standard speeds range from 27 to 900 strokes per minute and at the higher speeds and higher capacities particularly, the flow is continuous for all practical purposes. Gases and vapors are vented automatically. Standard units will develop pressures up to 2500 psig.

The pumping element is sealed and absolutely leakproof, and there are no packing glands or stuffing boxes. The unit is completely enclosed, yet easily serviced. Regulation is said to be easily adaptable to automatic control, utilizing direct instrument air signal. Valves are high speed type, having special valve and seat surfaces designed to be fast acting, positive seating and self cleaning. Valve service and replacement is also said to be very simple.

Controller Unit

A low-cost controller unit PTL for on-off or high-low control action in response to forces, weights, pressures, or torque measured by means of Baldwin SR-4 load cells, pressure cells, and torque pick-ups is announced by Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa.

The controller is operated in conjunction with the recently developed PTL amplifier and is recommended by the company for use where simplicity is important, available space is small, and accuracies of 2 to 5 per cent are satisfactory. Two controllers may be used with a single amplifier. A single-pole double-throw relay can be adjusted to trip anywhere over 0-100 per cent of full scale, as provided by the pointer knob. All adjustments are on the 6 × 7-in. front panel. A case is available.

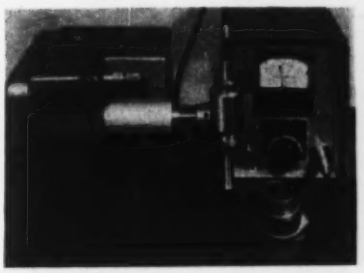


Reproduction Machine

A low cost, tabletop direct reproduction machine, designed for use in the engineering, drafting, and architectural fields, has been introduced by Charles Bruning Co. Inc., 4700 Montrose Ave., Chicago 41, Ill. The new unit is the Copyflex Series 100 model.

The machine has an operating speed of 12 fpm and has a printing width of eleven in. It can be used to make copies of the smaller size drawings which form a large part of reproduction work in the engineering, drafting, and architectural fields—rough sketches and finished drawings of component parts, details, and sub-assemblies, as well as specification lists, tabular listings, descriptive sketches, floor plans, and elevations.

The unit is a completely self-contained copying unit based on the diazo direct copying process; it does not require any exhaust ducts, darkroom facilities, special lighting, or plumbing. The machine makes positive copies directly from the original of anything drawn, written, printed, or typed on ordinary translucent paper.



Profilometer Pilotor

Micrometrical Mfg. Co., 345 S. Main St., Ann Arbor, Mich. announces a new linear pilotor for use with G-type profilometer tracers in measuring the roughness of short or hard-to-reach surfaces. Known as the type AD linear pilotor, this unit supports the tracer and provides a vibrationless straight line tracing movement of any desired length from $^1/_{32}$ in. to $1^1/_4$ in., with smooth and rapid reversals, it is claimed.

The piloting mechanism is at the top of a rigid column which is mounted on a 24 in. × 18 in. granite base plate. A motor drive assembly gives a reciprocating movement to a horizontal ram; and the ram carries a tracer holder, which is hinged to permit swinging the tracer upward. The tracer holder has a collet at the bottom for clamping the tracer in position, and a graduated collar at the top for fine vertical adjustment. Length of stroke is adjusted by a slideable sleeve and graduated plunger at the front of the pilotor housing.

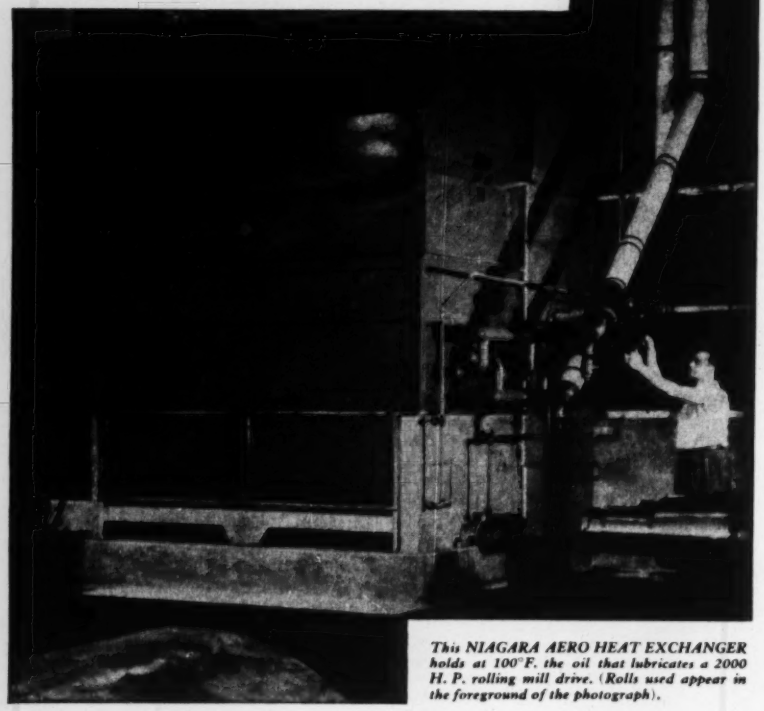
The piloting mechanism can be swung horizontally and clamped at any angle, the company says, thus permitting the tracer to reach over the back or end of the base plate, for measuring work that cannot be placed on the base plate. Details and specifications are given in Bulletin LT92, available on request from the company.

Actuator Motor

A series-wound 25-w miniature motor designed for use as a driving element in low- or high-speed linear- or rotary-actuator applications is described in a new leaflet, Form SR-43 available from Dalmotor Co., 1350 Clay St., Santa Clara, Calif.

The motor is illustrated, detailed in dimensioned outline drawings, and defined in a listing of electrical and physical characteristics. Performance data, given in graphic form, covers rpm, efficiency, output watts, and input amperes, over the torque output range to 4.25 oz in.

YOU CAN KEEP ACCURATE CONTROL OF LUBE OIL TEMPERATURE



This NIAGARA AERO HEAT EXCHANGER holds at 100°F. the oil that lubricates a 2000 H. P. rolling mill drive. (Rolls used appear in the foreground of the photograph).

The Niagara Aero Heat Exchanger uses atmospheric air to cool liquids and gases by evaporative cooling, removing the heat at the rate of input, controlling temperatures precisely. You save 95% of the cost of cooling water. You get great saving in piping, pumping and power, quickly getting back the cost of the installation.

You can cool and hold accurately the temperature of all fluids, air and gases, water, oils, solutions, chemicals for processes and coolants for mechanical and electrical equipment. You can cool welding machines, hydraulic and extrusion presses, plastic molds, furnaces, controlled atmospheres, quench baths, obtaining better results with precise temperature. You obtain closed system cooling, free from dirt or scale.

For further information, write for Bulletin No. 120

NIAGARA BLOWER COMPANY

Dept. ME, 405 Lexington Ave. New York 17, N. Y.

Niagara District Engineers in Principal Cities of United States and Canada

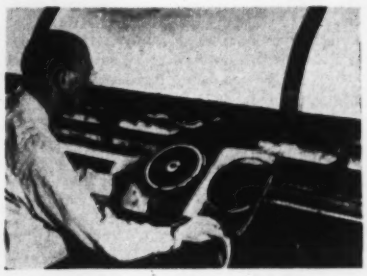
KEEP INFORMED — NEW EQUIPMENT, BUSINESS NOTES, LATEST CATALOGS

Extra-Duty Tapered Gear Pump

Especially designed for difficult service applications is an extra-duty model of its tapered-gear pump introduced by the East Shore Machine Products Co., Cleveland 23, Ohio. Developed to handle liquids containing materials of an abrasive nature or foreign matter which normally punishes a gear pump severely, the new U-3 model will outlast a conventional pump by many times in any tough application.

The pump will maintain its high initial mechanical and volumetric efficiency throughout its service life because, by reason of its special taper design, any wear which occurs is automatically taken up without effect on clearances. The impellor gears, are the straight spur type, and ground with a 2-deg taper after hardening to match the tapered recess in the housing. As wear occurs, spring tension on a floating back-up plate acts to force the gears into the taper bore of the case to maintain close fit and constant high vacuum.

It attains a 29-in. vacuum level under conditions of restricted flow. With a nominal capacity of 8 gpm, the pump will deliver up to 18 gal at 1000 rpm shaft speed, at pressures banging up to 250 psi. Construction details of the new U-3 pump are especially suited to heavy-duty service. Shafts are hardened and ground, and the unit is equipped with generously-dimensioned bronze bearings.

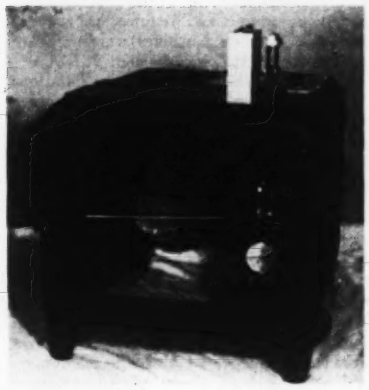


Traveling Thermometer

A new recording thermometer, designed to pass through a traveling oven with bread and other baked goods has been announced by the Bristol Co., Waterbury 20, Conn.

The instrument, completely self contained, is no higher than a loaf of bread when in its operating position. For use, it is simply laid on its back next to a pan of baked goods, and allowed to pass completely through the traveling oven. The company claims that when it emerges at the discharge end, a complete record of the actual temperatures encountered at each point along the way are inscribed on its smoke covered chart.

The recorder can also be used in non-food baking applications, where a low-clearance instrument is required for continuous conveyor, traveling tray, or other traveling-ovens. Bulletin T855, giving specifications and illustrating the thermometer, is available from the company.



Thinner Sheet Fatigue Tested

Fatigue properties of sheet stock (metals, plastics, etc.) as thin as 0.010 in. can now be determined on the Sonntag SF-2-U fatigue testing machine, it is announced by Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa. A new accessory fixture developed by Sonntag Scientific Corp. is furnished with the machine. Former minimum thickness of specimens was two and a half times this figure.

Fatigue testing of thinner sheet specimens is accomplished by holding one end of the specimen fixed (as before) and the other end free but guided in such a way as to produce maximum stresses in two lines across the specimen instead of one line. A new specimen shape is required. Stresses are produced by forcing the specimen into an S-curve or reversing S-curves at 1800 cycles per min.

A stress of 150,000 psi was produced in a 0.01-in. specimen of a certain material with less than $^1/_4$ in. deflection and 5.25 lb force. By former test methods this fatigue stress would have required approximately $^3/_4$ in. deflection and a force of 1.62 lb, both of which are outside the range of the machine. Machine capacity is 50 lb with amplifying fixture. Maximum deflection is $^1/_2$ in.

Air Motors Announced

Designed to combine in one compact unit a cylinder, a four-way valve and a wide variety of valve controls, Lehigh air motors are now available in bores of $1^1/_2$, 2 or 3 in. with any desired stroke from Lehigh Foundries, Inc., 1500 Lehigh Drive, Easton, Pa. The company says only one air connection is required to bring air to the air motor.

The built-in valve can be operated either manually, or by air or electricity. If desired, it can be operated by one of these means in one direction and another of them in the opposite direction. Air operation is by means of poppet or bleeder valves which control the movement of the four-way slide valve and therefore control the air motor itself.

The valve can be operated electrically utilizing any one of three different types of control for the built-in solenoids. The valve body is made of high quality bronze. The valve piston is stainless steel. The slide valve is bearing bronze sliding on a steel bar stock base which assures freedom from grooving.

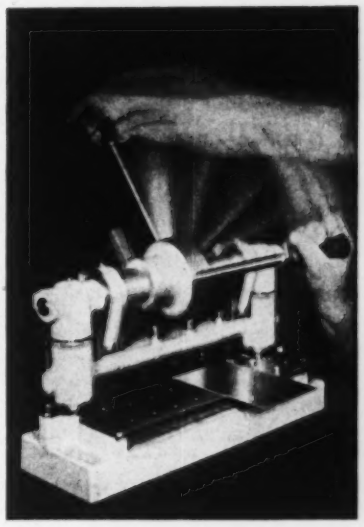
Lehigh air motors can be furnished with or without adjustable cushions at either or both ends of the cylinder. All units have adjustable speed control of the piston rod in both directions. Nine different types of mountings are available. The motors are suitable for air pressure up to 200 psi.

Electric Brakes, Clutches

A complete new line of electric brakes and clutches, suitable for use in all types of industrial machinery, has recently been put on the market by the Warner Electric Brake & Clutch Co., Beloit, Wis., company officials announce.

The new brake features a replaceable facing, similar to the replaceable lining found in automobile brakes. This facing makes it possible for the brake to last as long as any machine on which it is installed, since the only part subject to heavy wear—the facing—can be easily changed. Warner executives point out that the new brake is extremely compact and simple in construction. It contains only three main parts—the field, the armature, and the replaceable face.

Over 85% of the torque wrenches used in industry are
Sturtevant
TORQUE WRENCHES
Read by Sight, Sound or Feel.
● Permanently Accurate
● Practically Indestructible
● Faster—Easier to use
● Automatic Release
● All Capacities
in inch grams...inch ounces...inch pounds ...foot pounds
Every manufacturer, design and production man should have this valuable data. Sent upon request.
W. A. Sturtevant Co.



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Check these features and you'll want a DI-ACRO* SHEAR

- **PRECISION** — strips less than .025" wide accurately sheared. Thousands of parts exactly duplicated.
- **CUTTING SPEED**—rivals that of power machines.
- **RATED CAPACITY**—16 gauge.
- **EASY TO OPERATE**—a woman can operate it.
- **CHOICE OF MODELS**—available in four sizes. Widths from 6 to 24 inches. Four power models also available.
- **ENGINEERING SERVICE**—always at your disposal.
- **PORTABLE**—readily moved.
- **RUGGEDLY BUILT**—backed by one year warranty.
- **DELIVERY**—immediate on most models.
- **COST**—that's good too.

*pronounced Die-ack-ro

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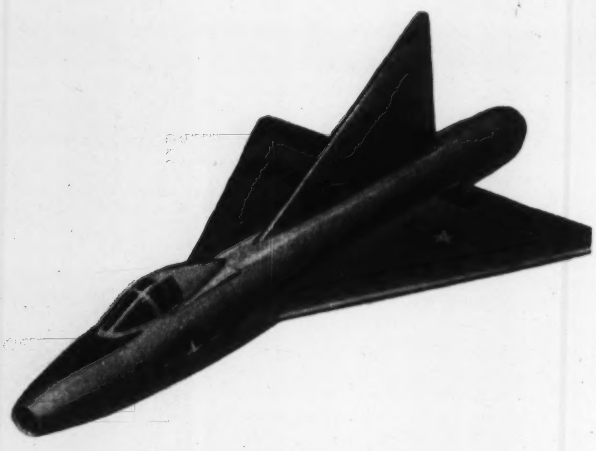


THE CONVAIR CHALLENGE TO ENGINEERS OF EXCEPTIONAL ABILITY

Beyond the obvious fact that Convair in San Diego offers you a way of living judged by most as the nation's finest from the standpoint of weather, beauty and interesting surroundings, the Convair Engineering Department offers you challenges found in few places.

It is, we believe, an "engineers" engineering department—interesting, energetic, explorative — with the diversity that means security for capable personnel.

As proof, consider this: Convair developed and flew the world's first turbo-prop airplane, first delta-wing airplane, first delta-wing seaplane — engineered and built the world's biggest transport, the world's safest high-performance commercial aircraft.

Or this: Convair's B-36 is the world's largest operational bomber, Convair's B-24 Liberator was World War II's most used heavy bomber, Convair's XP5Y-1 holds the world's endurance record for turbo-prop aircraft.

Or this: Convair has been awarded the nation's first production missile contract and the first production contract for supersonic interceptors.

Currently . . . Convair has the greatest diversity of aircraft engineering projects in the country, including high-performance fighters, heavy bombers, large flying boats, transports, trainers, seaplane fighters and guided missiles.

Currently... Convair has a completely integrated electronic development section engaged in advanced development and design on missile guidance, avionic projects and radar systems.

Would you like to join us? We earnestly need engineers of proven ability — men who want to make full use of their time, their minds, their skills and abilities solving the complex problems confronting us in these projects. If you are such a man, write us and we'll send you a free booklet about us, plus other interesting material to help you make the decision.

Write: H. T. BROOKS, Engineering Personnel Department M-9

CONVAIR

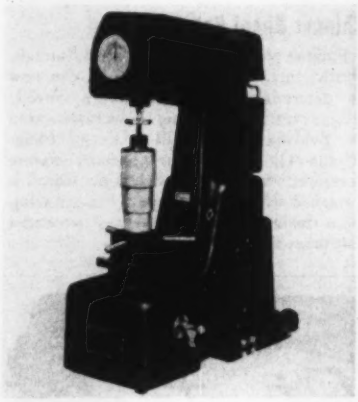
3302 PACIFIC HIWAY

in beautiful San Diego, California

Adjustment for wear on the brake is completely automatic and requires no manual servicing, even on machines which operate around the clock, it is explained.

The electric clutch operates on a "stationary field" principle, said to be a new Warner method for inducing current into a rotating coil. The new clutch needs no slip rings or brushes. Both the replaceable face brake and the stationary field clutch can be controlled by a simple push-button, under the control of an operator, or automatically controlled by electric switches, relays, electric eyes, or any other type automatic system.

At the present time, the company announces, both the brakes and the clutches are being manufactured in the torque range of 8 lb in. to 700 lb ft. Smaller and larger sizes are being developed for future production.



Hardness Tester

A Rockwell motorized hardness tester, Model Y, which is semi-automatic in operation, has been perfected and announced by the Wilson Mechanical Instrument Div., American Chain & Cable Co., Inc., Bridgeport, Conn. According to the manufacturer, the device features a short test cycle to permit an increased number of Rockwell readings to be taken and recorded within a definite time period.

The motor's function in the test cycle is to remove the major load. The cycle of major load operation is less than 2 seconds. Its application is controlled through a dash pot, which gives infinitely variable speed control. Power is supplied to unit from a 110 volt, 60 cycle, single phase a-c line.

The instrument features an illuminated dial gage, indenter light and the company's Set-O-Matic dial gage which is said to eliminate setting the large hardness indicator pointer to zero manually because the pointer will automatically return to zero when the minor load is applied.

The unit is furnished with a $1/16$ in. steel ball penetrator chuck, complete set of anvil, dead weights for applying 60 kg, 110 kg and 150 kg major loads. It is equipped with two B scale and two C scale test blocks and a vinyl plastic overall cover. Bench space required is 12 by 20 in.

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Profilometer Tracer

Micrometrical Mfg. Co. announces the Profilometer type GC tracer for measuring surface roughness across the bottom of flat-bottomed grooves and slots to $^1/_4$-in. depth and behind shoulders to $^1/_4$-in. height. When measuring crosswise, it permits $^1/_{16}$-in. length of trace in slots of $^5/_{32}$-in. width, and greater length of trace in wider slots. It measures lengthwise in slots as narrow as $^5/_{64}$ in.

The tracer can also be used in ID's from $^{25}/_{64}$-in. to flat, and on all other internal and external surfaces where the geometry of the work permits and where the part can be mounted with the work surface approximately horizontal. Details and specifications are given in Bulletin LT93, available on request from the company, 345 S. Main St., Ann Arbor, Mich.

Plunger Pump Bulletin

A bulletin on vertical triplex, single action plunger pumps is being offered by Worthington Corp., manufacturers of pumping, industrial, construction, air conditioning and refrigeration equipment. Illustrated by photos, charts and line drawings, the bulletin contains information about features, applications, ratings, dimensions and specifications of the VTE, VTE-1 and VTE-2 types of Worthington plunger pumps.

Designed for application in many fields including the petroleum industry, water flooding and salt water disposal, hydraulic press systems, hydraulic descaling systems, the plunger pumps offer such features as interchangeable plunger sizes; individual valve covers; flanged suction and discharge openings; stuffing box drains; complete automatic oiling system; straight-through liquid flow; close-clearance liquid end; and synchronous suction valve unloaders, supplied as optional equipment. Copies may be obtained from Advertising and Sales Promotion Dept., Worthington Corp., Harrison, N. J., specifying Bulletin W-414-B45.

Packaging Control

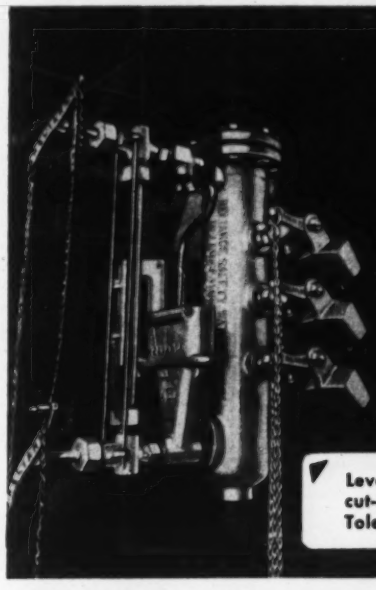
A special electric control system, incorporating a new-type Warner electric brake, has been developed for high-speed packaging machines by Warner Electric Brake & Clutch Co., 105 W. Monroe St., Chicago 3, Ill.

The control system enables the machines to wrap up to 130 units of any size or shape per minute, the company says. On standard-sized packages, the machine can wrap in excess of 150 units per minute.

The new machines are entirely self-operating. The articles to be packaged are fed through a hopper into one end of the machine. Once inside the machine, they are wrapped, sealed (either by glue or heat process), the pre-printed label is applied, and the product emerges at the other end ready to be boxed in shipment quantities.

The machine can package goods in a variety of materials including glassine, cellophane, greaseproof, wax paper, plastics, metal foil and ordinary wrapping paper.

Isolated Circuits Do the Trick!



Give you prompt, positive . . .

- fuel cut-out
- low water alarm
- high water alarm
- pump start
- pump stop

(or selection of these facilities)

Levalarm EA15 supplies quick fuel cut-out on the two 200 psi boilers at Toledo University.

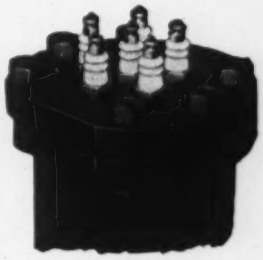
Reliance Electrode-Type Levalarms

for pressures up to 1100 psi.

You can operate alarms and fuel cut-out, start and stop pumps by means of these latest Reliance devices. Installed on or in the water column, the four models of the new Levalarms provide a desirable selection for various control combinations on boiler pressure from the lowest to 1100 psi. They're ideal for use on package boilers.

Operated by relays and special transformer-created currents, Levalarms are entirely electrical — have no bellows or stuffing boxes, vacuum tubes or magnets. They take their commands from the boiler water itself, as it rises or falls in the water column.

It's easier to understand these devices by reading the special catalog bulletin D2, completely illustrated. Please write for it.



How electrodes are installed in water column head (and protected by cover) for Levalarms EA17 and 18.

The Reliance Gauge Column Company
5902 Carnegie Avenue • Cleveland 3, Ohio

The name that introduced safety water columns . . . . in 1884

Reliance®

BOILER SAFETY DEVICES

Wing
REVOLVING
UNIT HEATERS
The Moving Airstream Touches the Worker for only a few Seconds at a Time
NO SICKENING HOT BLAST!
THAT is the big difference between most unit heaters and the WING Revolving Heater. The soft airstream from the slowly revolving discharge outlets creates a warm, gentle, yet live sensation of comfortable well-being that is without equal for keeping workers contented and productive.
. . And in the Summer time with the steam turned off and the fans on, these same revolving discharge outlets will create a pleasing, cooling effect on the hottest days.
Write for Bulletin HR-6
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TURBINES

KEEP INFORMED — NEW EQUIPMENT, BUSINESS NOTES, LATEST CATALOGS

Geared Joint

Stow Mfg. Co., 52 Shear St., Binghamton, N. Y., has announced a new mechanical device for transmitting torque around a bend, called a "geared joint."

This joint transmits power by a system of bevel gearing. Unlike a universal joint, the geared joint has no maximum angle of operation, it will operate in any angle up to 360 deg.

The primary use for the geared joint is for making sharp bends with flexible shaft or reach rod remote controls for valves. When installing valve controls it is often necessary to make sharp bends in the controls to avoid obstacles, company engineers point out. The geared joint makes it simple to detour around these obstacles since the workman can set the joint for any angle necessary.

The joints are available in three sizes, ranging from $\frac{1}{2}$ to $1\frac{5}{8}$ in. flexible shaft diameters.

Produces Silicon Transistors

Texas Instruments, Inc., 6000 Lemmon Ave., Dallas 9, Tex., has announced the start of commercial production on silicon transistors. By using silicon instead of germanium, the initial commercial silicon transistor immediately raises power outputs and doubles operating temperatures.

The new silicon transistors are said to be in small, but growing, volume production and that units are immediately available on a limited quantity basis. The silicon transistors are ready for field application and are equipped with glass-to-metal hermetic seals.

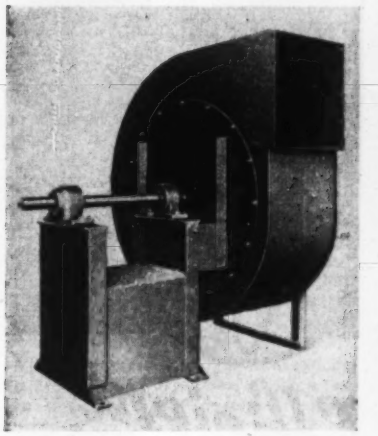
Largest Meter

A new model M-200 added to the line of the Meter Div. of A. O. Smith Corp., Box 584, Milwaukee, Wis., is described as the largest meter in the industry. It has a rated capacity of 2000 gpm under a working pressure of 1200 psi.

Although the meter weighs 6275 lb, the inner metering unit weighs only 800 lb. Principal use of the M-200 will be on high pressure product and crude oil lines, according to the company.

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS



New Fan Series

Clarage Fan Co., Kalamazoo, Mich., has announced a new series of fans, designated as type XL, for industrial air and materials handling. The fans range in size from 11 through 60 in. inlet diameters with pressures to 18 ft SP and volumes to 130,000 cfm.

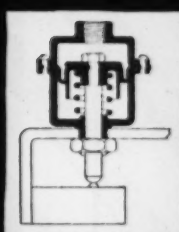
The smaller fans in the series provide a universal discharge, can be furnished with three different interchangeable wheels and are reversible when equipped with rim or open type wheels, according to the company. A bulletin, No. 702, describing the new series is available from the company.

Portable Vacuum Cleaner

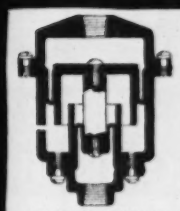
U. S. Hoffman Machinery Corp., Air Appliance Division, 105 Fourth Ave., New York, N.Y. has introduced a new 5 hp portable vacuum cleaner, designed to operate two 50-ft $1^1/_2$-in. hoses simultaneously—or one 75-ft length of $1^1/_2$-in. hose.

The Hoffco-Vac 35 has a large dust bucket and is equipped with an exhauster and motor which produce 6.5 in. hg suction. The company recommends the machine for use as a general housekeeping tool to keep floors, wall, lights and other dust catchers around the plant spruce and clean, and says it fills a specific need in industry for a high-vacuum, low-cost cleaner. Because of dynamically and statically balanced impellers in the exhauster, the machine is said to operate with little vibration or noise.

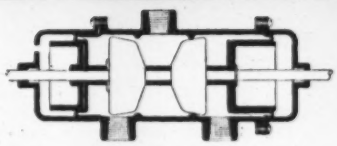
Bellofram*



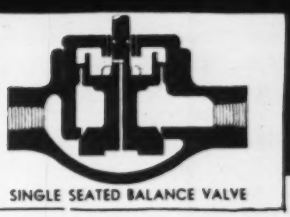
PRESSURE SWITCH



PRESSURE VOLUME TRANSFORMER



BALANCED PLUG VALVE



SINGLE SEATED BALANCE VALVE

IN YOUR FLUID SYSTEMS

When you combine "Bellows" with "Diaphragm" you get "Bellofram." This amazingly simple but new idea in Fluid Barriers performs both bellows and diaphragm functions — easier, better and simpler. A standard Bellofram can be applied to your product.

WHAT THEY ARE

Bellofram seals are long-stroke, deep convolution, constant-area diaphragms with extreme flexing life and exceptionally low spring gradient. They are relatively unaffected by foreign matter, and since they need no lubrication, they are clean. They eliminate leakage. Friction-free, rolling action gives exceptional cycle life. High dielectric strength and remarkable resistance to chemical action are important features. Area accuracy is affected only by surrounding components to which they automatically adapt themselves.

APPLICATIONS UNLIMITED

Bellofram seals may be used in almost any piston-cylinder application, for either precision measurement or frictionless power. Infrequent replacement is the only maintenance. Effective area can be controlled to within less than 0.1% over the working stroke. Efficient operation can be obtained at pressures varying from inches of water to 500 PSIG max. over a wide temperature range. Plan to incorporate Bellofram seals into both your old and new designs. A sketch of your device will help us help you. Strict confidence observed. Write today.

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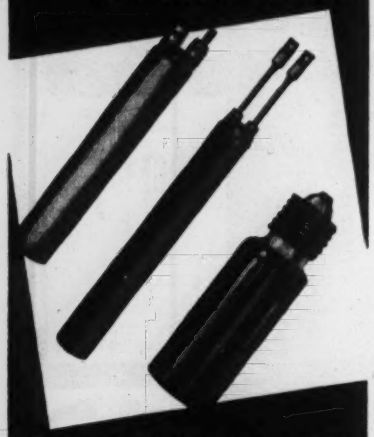
144 MOODY ST., WALTHAM, MASS.

For concentrated
HEAT
for confined areas



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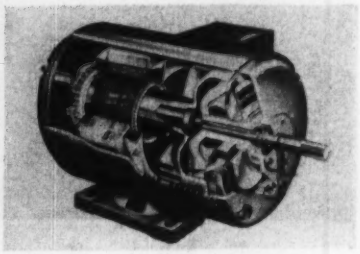
Molding Materials

Three new and improved plastic molding materials have been announced by Bakelite Co., a div. of Union Carbide and Carbon Corp., 260 Madison Ave., New York 16, N.Y.

Improvements in moldability, curing speed and general properties that indicate new cost reductions for molders, have been developed by the company's research laboratories for each of the materials.

One is a general-purpose Bakelite styrene plastic said to combine higher plasticity with faster set-up than previous materials. The second is Bakelite C-11 (acrylonitrile-styrene) plastic with greater toughness and chemical resistance, and the third is a general-purpose, brown Bakelite phenolic molding plastic said to be of special interest to molders of electrical items.



Fractional HP Drives

A line of combination power and speed control units, engineered to meet specific needs of fractional horsepower drives, has been developed by the Dynamatic Div. of the Eaton Mfg. Co., Kenosha, Wis.

Known as fractional horsepower Adjusto-Spede drives, the units are an integral combination of ac constant speed induction motors, eddy-current couplings, and electronic speed controls.

The manufacturer reports that the drives are being used for business machines, printing presses, machine tools, conveyors, wire drawing equipment, welding machines, metal and paper rewinds, and laboratory experimental machines. Under constant torque or fan type load, the Adjusto-Spede Drive may be operated continuously at any speed within the limits of the speed range. Electronic control insures speed stability of ±2 per cent of top speed at any point within the range.

A simple connection to a standard single or three-phase electrical power line is all the wiring that is required. For remote control operations, only minute current is required for the speed setting potentiometer circuit, which may therefore, be located as far as 100 ft away from the equipment.

Weighing less than 50 lb, the models are designed for mounting on wall, ceiling, or floor, without modification. Drives are available in 115/220 v, single phase or 220/440 v, three phase; ¼, ⅓, and ½ hp at 1600 rpm, 10:1 constant torque speed range; ½ and ¾ hp at 3200 rpm, 20:1 range.

Efficient combustion with
Enco Burners

FOR ALL GRADES OF LIQUID FUEL

Enco Burner Units of Steam or Mechanical Atomizing Types are made in various sizes with capacities from 1 to 1000 gallons per hour.

Designed for operation either with or without air registers and for natural or forced draft.

The Enco Interchangeable Atomizer is made for instant change of guns for operation by either steam or mechanical system or to cover a wide range of capacity.

Enco Atomizers are used with various types and makes of pulverized-coal and gas-burner units to provide a dual fuel unit for cold starting, or for full-load operation when coal or gas is not available, or use when oil is the more economical fuel.

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NEW EQUIPMENT
BUSINESS NOTES
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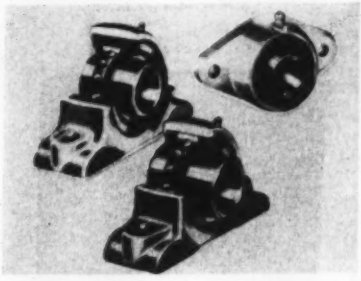
Inductor Excitation System for Generators

A new exciter system available as original equipment with turbine-generator units or for modernization of older generators has been announced by Allis-Chalmers Mfg. Co., Milwaukee 1, Wis.

In the system, brushes and commutator of the conventional exciter and all rotating windings have been eliminated by substituting an inductor alternator for the usual d-c machine. Power for excitation is generated at high frequency and then changed to direct current by a bank of selenium rectifiers. The rotating element of the new a-c exciter is adaptable to over-hung mounting on most 3600-rpm generators.

When compared with the conventional d-c exciter-regulator system, the new exciter is claimed to eliminate most maintenance requirements while providing superior reliability and performance.

The first of these new exciter systems will be installed soon by Allis-Chalmers on a 43,750-kva, 3600-rpm machine at Iowa Power & Light Co., Des Moines, Iowa.



Bearing Mountings

New improvements in the light duty ED series of regular and rubber insulated ball bearing pillow block and flange mountings have been announced by the Ahlberg Bearing Co., 3025 W. 47th St., Chicago, Ill.

The mountings are now equipped with double setscrews for more permanent shaft locking; have a standard gun type of lubricant fitting instead of the ball check oil fitting formerly used.

The series includes the ED Pillow Block, the FED Flange, and the EDR rubber- insulated pillow block with rubber mounting.

Further information is contained in Bulletin 7149-A which is available from the company.

Hydraulic Transmissions

A line of variable speed integral hydraulic transmission units adaptable to textile machinery drive applications is now available from Vickers, Inc., 1400 Oakman Blvd., Detroit 32, Mich. These package units have variable displacement, axial type piston pumps and hydraulic motors, and suitable valves and controls enclosed in a bolted cast iron housing assembly. They are designed

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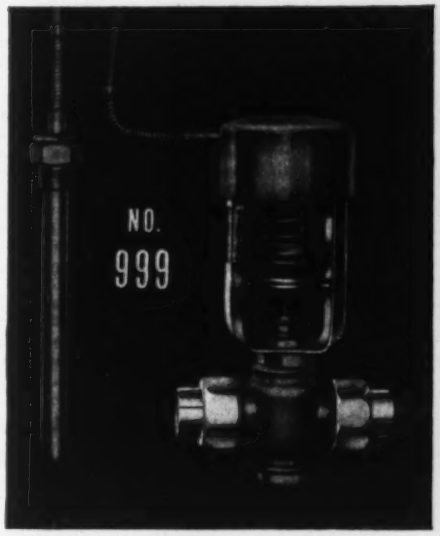

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Sandia Corporation, a subsidiary of the Western Electric Company, offers outstanding opportunities to graduates with Bachelor's or advanced degrees, with or without applicable experience, in the above fields.

Engineers and scientists at Sandia Laboratory, an atomic weapons installation, work as a team at the basic task of applying to military uses certain of the fundamental processes developed by nuclear physicists. This task requires applied research as well as straightforward development and production engineering.

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Sandia engineers and scientists design and develop complex components and systems that must function properly under environmental conditions that are much more severe than those specified for industrial purposes. They design and develop electronic equipment to collect and analyze test data; they build instruments to measure weapons effects. As part of their work, they are engaged in liaison with the best production and design agencies in the country, and consult with many of the best minds in all fields of science.

Sandia Laboratory, operated by Sandia Corporation under contract with the Atomic Energy Commission, is located in Albuquerque — a modern, mile-high city of 150,000 in the heart of the healthful Southwest. Albuquerque offers a unique combination of metropolitan facilities plus scenic, historic and recreational attractions; and a climate that is sunny, mild, and dry the year around. New residents have little difficulty in obtaining adequate housing.

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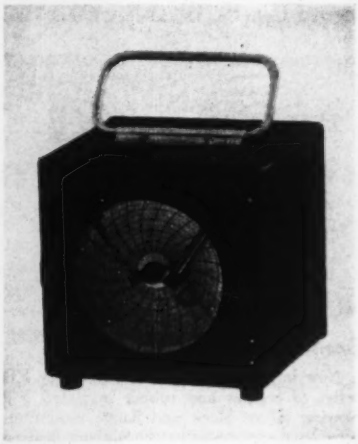
to cut drive maintenance costs and provide optimum drive characteristics and dependability.

The transmissions can be used on machine drives on pads, tentering frames and dye becks. They can be run constantly at any selected speed from 0 to 1000 rpm. No limitations on creep speeds are imposed by either speed selection or length of operation, the company says.

The transmissions are usually driven by conventional squirrel cage a-c motors having no special starting characteristics and a nominal input speed of 1140 rpm. They are available in 5, 7½, 10, 15 and 25-hp standard models. Six basic types of standard adjustable and interchangeable control assemblies can be provided on the transmissions. These include stem, handwheel, cylinder, pressure compensator, servo and electric control. When the individual control is on the pump end of the transmission, it regulates output speed and horsepower. When it is on the motor end, it also regulates output shaft speed and torque.



Miniature Electrical Recorder

A new lightweight, direct-writing recorder for voltage and current records, in both a-c and d-c models, has been announced by the Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N.J. Its field of usefulness is said to include recording amp-hr demand in power company surveys; checking reports of low voltage, overloads, or unbalanced conditions; monitoring radio detectors when used with electronic amplifiers; recording current and duration in electroplating and metal refining; recording speed, as well as life tests of batteries of all types, lamps.

The Weston Cormag® mechanism employed provides shielding so that the magnetic field created by a conductor carrying 15,000 amp at a distance of 3 ft from the instrument would cause a temporary error of less than 1 per cent. The Cormag® mechanism, using a large movable coil, gives improved performance with a high torque-

DESIGNERS

for layout and design of electronic and mechanical components of radar systems and computing equipment.

1
THE COMPANY

Hughes Research and Development Laboratories form one of the nation's leading electronics organizations. The Laboratories are presently engaged in development of advanced electronic systems and devices produced by the Hughes manufacturing divisions.

2
AREAS OF WORK

The work calls for layout and production design of: 1. Reliable, maintainable electronic units. 2. Unique electromechanical devices. 3. Installations of electronic equipment in interceptor airframes.

3
THE FUTURE

Designers experienced in the field of electromechanical design for production, or those interested in entering this field, will find outlets for their abilities and imagination in these active areas. New electromechanical techniques are opening new applications of airborne electronic equipment. Hughes designers will have the benefit of working experience in these fundamental developments.

Relocation of the applicant must not disrupt an urgent military project.

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to-weight ratio, and allows increased sensitivity where needed.

For d-c measurement, Model 6401 is available in ranges of from 1 ma to 5 amp and in voltage ranges of from 100 mv to 300 v, self-contained. Higher ranges can be obtained through the use of accessory shunts or multipliers. For a-c measurement, the rectifier type model 6402 is available in current ranges up to 5 amp, self-contained, and in voltage ranges up to 300 v, self-contained. Higher voltage ranges can be obtained through the use of external multipliers; higher current ranges with a Model 604 type 1 current transformer. Both models measure approximately $6^{3}/_{4}$-in. high × $6^{1}/_{4}$ in. wide by 7 in. deep, and use 4 in. diam charts.

Torque Limiter-Coupling Units

New adjustable torque limiter-coupling units that provide overload protection for a wide variety of machinery drives with direct-connected shafts are now available from Morse Chain Co., 7601 Central Ave., Detroit 10, Mich.

Combining the features of an adjustable slip-clutch overload device with those of a flexible coupling, these compact units, are ideally adapted to motor drives with torque loads up to 260 ft lb which include a direct-coupled motor or motor and speed reducer combination. In drives of this type the torque limiter-coupling unit connects the motor shaft or the output shaft of the speed reducer with the primary drive shaft.

The torque limiter-coupling units are made in a nominal No. 5, $5^{1}/_{2}$-in. size. Maximum torque capacities are 130 ft-lb for the Model 555-1 and 260 ft-lb for the Model 555-2.

The units have a 6-in. OD and are approximately $5^{1}/_{2}$ in. long overall.

Standard bore sizes are 1, $1^{1}/_{8}$, $1^{1}/_{4}$, $1^{3}/_{8}$ and $1^{1}/_{2}$ in. for both models. Minimum plain bore size is $^{3}/_{4}$ in. for reworking to fit other than the standard bore sizes.

Polyvinyl Blowers

New Boltaron 6200 pvc blowers for expelling corrosive air, fumes and gases have been introduced by Industrial Plastic Fabricators, Inc. After several months of field testing under extremely severe environmental conditions the Boltaron blowers showed no signs of corrosion or any adverse effect. The impellor blade is also fabricated of plastic with threaded spinner cap aerodynamically balanced for smooth, vibration-free, high speed operation. The back-curved design of the blade prevents overload and creates less turbulence.

All shaft areas and bearings are protected and sealed against corrosive attack. The lightweight, smooth-surfaced, non-porous, non-plasticized polyvinyl chloride does not pick up residual matter from the air or gases. Presently the line of blowers includes capacities of 500, 1500, and 4300 cfm. Details may be obtained from Industrial Plastic Fabricators, Inc., Endicott St., Norwood, Mass.

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DO YOU WANT | LONG LIFE, EASY MAINTENANCE, RELIABILITY

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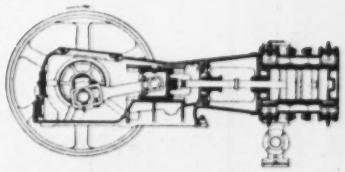
AIRCHEK VALVE

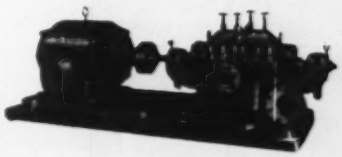
Automatically prevents reverse flow through Compressor and also dampens pipe line pulsations.

This Check Valve should be on EVERY Compressor. Bulletin 509 E



OILFREAIR & OILFREGAS Compressors Class ATL with steel-backed carbon cylinder-liners. Guaranteed to compress free of any trace of oil or oily vapors.

Bulletin 600 E



PENNSYLVANIA 4-Stage THRUSTFRE Centrifugal Pump for Boiler Feeding, General Power Plant and Industrial Use.

Bulletin 237 E

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EASTON, PA.

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says Detroit Edison—reduces fire hazards, cuts dust damage to machinery, and salvages profitable quantities of dust from 4,500,000 tons of coal handled annually.

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50th Anniversary Medallion

Pangborn engineers will be glad to discuss *your* dust control needs, show you how Pangborn equipment can save you time, trouble, and money. For more information, send for Bulletin 909-A today! Write to: PANGBORN CORPORATION, 2200 Pangborn Blvd., Hagerstown, Maryland.

Guide Bushings

Carl Hirschmann Co. Inc., Manhasset, N. Y., announces a design in carbide-lined guide bushings for Swiss type automatic screw machines. Instead of the conventional straight slots, the new bushings have been designed with helical spiral slots which are said to provide better lubrication of the bar. They are inclined in the same direction as bar-rotation to assure a quicker disposal of any chips which might enter the bushing, permitting the stock to be held tighter without risk of seizing.

Gate Valve Design

Longer-wearing wedges, stronger stem-to-wedge connections and a union bonnet giving increased efficiency are incorporated into newly designed forged steel gage valves announced by the Ohio Injector Co., Wadsworth, Ohio.

The wedges are made of 13 per cent chrome stainless steel for corrosion resistance and are duracased to at least 1000 Brinell hardness to prevent galling and excessive wear caused by closure upon abrasive particles in the flow.

The newly designed stem-to-wedge connection is said to increase pull-out strength to many times the theoretical requirement.

The design distributes the pull-out load more efficiently throughout the wedge structure to meet the most stringent specifications of valve buyers, according to the company. In the union bonnet construction a body-to-bonnet joint of male-female type provides a recess for the gasket, seating it accurately and more securely, thereby reducing the possibility of leakage and blown gaskets.

A folder, Bulletin 195, is available from the company.

Holding Coil Switch

A versatile new holding coil switch said to perform the functions of a relay plus two conventional switches, has been announced by Hetherington, Inc., Sharon Hill, Pa. Known as the Hetherington A1200 series holding coil switch, the new unit has a built-in solenoid which holds the switch on contact until the solenoid coil circuit is externally interrupted.

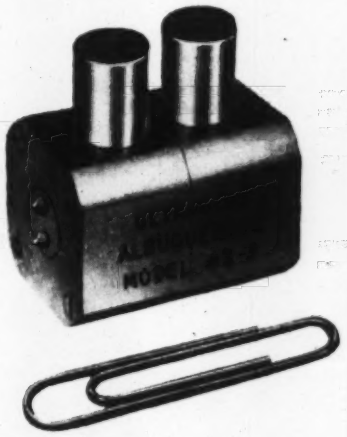
The circuit may also be broken manually by pulling the switch knob. Besides reducing the size and weight of conventional holding circuits, the switch eliminates the wiring needed to interconnect the relay, switches, and pilot light commonly used in these circuits. Life of the switch is said to be in excess of 25,000 make-and-brake cycles at rated load.

The switches are currently used to control prop feathering and auto pilot mechanisms in military and commercial planes. Industrial applications range from circuit overload control to end-of-sequence shut-off, and numerous uses in annunciator systems and other devices.

The switches weigh 3 oz, have a body diameter of $^{15}/_{16}$ in. and an overall length of $3^{3}/_{8}$ in. including the large anodized

aluminum knob. The switch mechanism is completely enclosed.

Present types have 240 ohm coils for 30 v d-c operation. Contacts are rated for a 5 amp inductive load at 30 v d-c. In order to meet the severe shock and vibration requirements of military specifications, the coil has been designed to hold the switch closed with a 1 lb load suspended from the plunger knob and with only 18 v d-c applied to the coil. For additional humidity protection the switch can be fitted with a moisture resistant silicone rubber boot.



Pressure Transducer

Ultradyne Engineering Labs., Inc., PO Box 8007, Albuquerque, N.M., announces a new Model S-3 pressure transducer. This gage operates on the variable reluctance principle and is said to be suitable for use with a wide variety of recording and telemetering systems. When the gage is connected in an electrical bridge circuit, the output signal will be proportional to the input pressure.

The transducer is designed for transient and high frequency pressure measurements. Because of its small size, low temperature shifts, small hysteresis, the model also has decided advantages for many static and slow response applications. One of the gage's more specialized uses is for the measurement of transient differential pressures.

As a result of being fabricated from invar (an iron-nickel alloy) the gage is resistant to corrosion and has the ability to withstand pressure overloads in excess of 2000 per cent without zero shift.

New Chart Paper, Ink

A new line of chart paper and recording inks has been announced by Minneapolis-Honeywell Regulator Co.'s industrial division, Minneapolis, Minn. The chart paper is claimed to provide up to 100 per cent greater accuracy in recording data. Primarily this is accomplished by controlling the expansion and contraction changes affected by humidity variations of the paper.

The new paper has also been specially sized so that the new inks will produce a clean, accurate record.

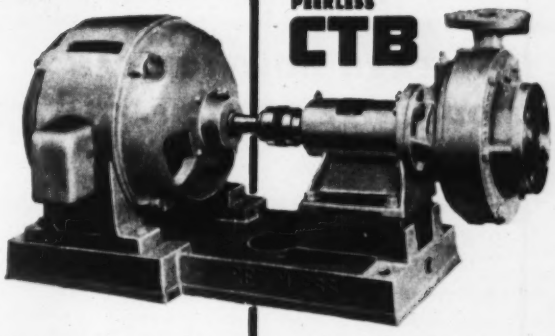
What's NEW in pumps from PEERLESS PUMPS ?

HERE'S A *NEW* CHEMICAL TRANSFER PUMP THAT HANDLES MOST ALL CLEAR CORROSIVE LIQUIDS

WETTED END IS MADE OF TYPE #20 ALLOY STEEL...

FEATURES MECHANICAL SHAFT SEAL CONSTRUCTION...

PEERLESS **CTB**



SIMPLICITY IS THE ESSENCE OF GOOD DESIGN and this new chemical transfer pump qualifies in every modern detail. Its frame and bracket construction is extra heavy. Its vertical split case permits easy inspection of rotating parts. Its open type impeller, with repelling vanes on back of shroud, is highly efficient. Its design with and for a mechanical shaft seal, reduces shaft overhang, cuts down bearing wear and eliminates packing and packing maintenance. Its wetted end of Waukesha No. 20, a high nickel-chrome alloy, handles most all clear corrosive chemicals. Available in 4 sizes, a Peerless type CTB transfer pump fits perfectly into both present plants and future plans of chemical and plant operation engineers, to lower costs of pumping and to lengthen time between pump servicing.

MAIL COUPON FOR COMPLETE INFORMATION

A 6-page bulletin describes the modern Peerless chemical transfer pump illustrated above. Use coupon at right for your copy.

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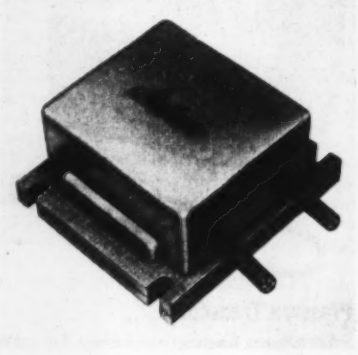
Fractional HP Units

Reeves Pulley Co., Columbus, Ind., announces a complete redesign of its fractional hp vari-speed Motodrive. The new unit is available in 1/4, 1/2, 1/2 and 3/4 hp sizes in speed ranges from 2:1 to 10:1.

The unit is available in horizontal and vertical models and also 45 deg. and with vertical down output shaft. Speeds from 3 to 4660 rpm are available. The design has a threaded spiral groove lubrication system designed to assure complete coverage of lubricant over all sliding surfaces. In case of excessive lubrication, an exclusive overflow outlet carries excess lubricant away from the disk faces and V-belt.

A bulletin, M-543, describing the unit is available from the company.



Linear Accelerometers

Statham Laboratories, 12401 W. Olympic Blvd., Los Angeles 64, Calif., offers a series of temperature controlled linear accelerometers in ranges from ±0.5g to ±15g designed to satisfy the need for acceleration transducers which perform reliably under variable temperature conditions such as are encountered in flight applications. Special packaging has been developed by the laboratories to maintain constant dynamic as well as static characteristics through wide ambient temperature variations. Operation through the ambient temperature range, −65 F to 120 F is afforded by means of an electrical heater jacket with a peak power input of 20 to 30 w. The temperature controlled linear accelerometers are described in catalog AT-1, available upon request.

Long Range Air Gage

Dimensionair air gage model DA-101 with 5000 to 1 magnification is now in production at Federal Products Corp., 1144 Eddy St., Providence, R. I.

The gage has a range of .0015 in. Each graduation on the precisely calibrated dial is equal to .000020 to make it easier to insert gaging plugs into the workpiece and reduce the wear on the plugs. The approach range is also long, which gives the operator a chance to see how he's doing before finished size is reached.

Vertical Shaft Pumps

Nagle Pumps, Inc., 1299 Center Ave., Chicago Heights, Ill., has introduced a new series of vertical shaft pumps, designed to afford a wider choice of settings, higher heads and greater design flexibility for abusive pumping applications. The series is comprised of the types CWO and CWS wet pit units for the submerged applications and CDO and CDS dry pit units for outside mounted applications.

CWO and CDO units have no submerged bearings, and are similar in design to the SWO pumps which have been under construction for many years. CWS and CDS units are equipped with submerged bearings and are available in extended setting lengths by the inclusion of additional intermediate bearings. All designs are available with packed or sealed stuffing boxes at floor plate level. Literature is available from the company.

Chain Hoist Introduced

A new streamlined, all-purpose chain hoist capable of handling loads up to 25 tons has been introduced by the Wright Hoist Div. of American Chain & Cable Co., York, Pa.

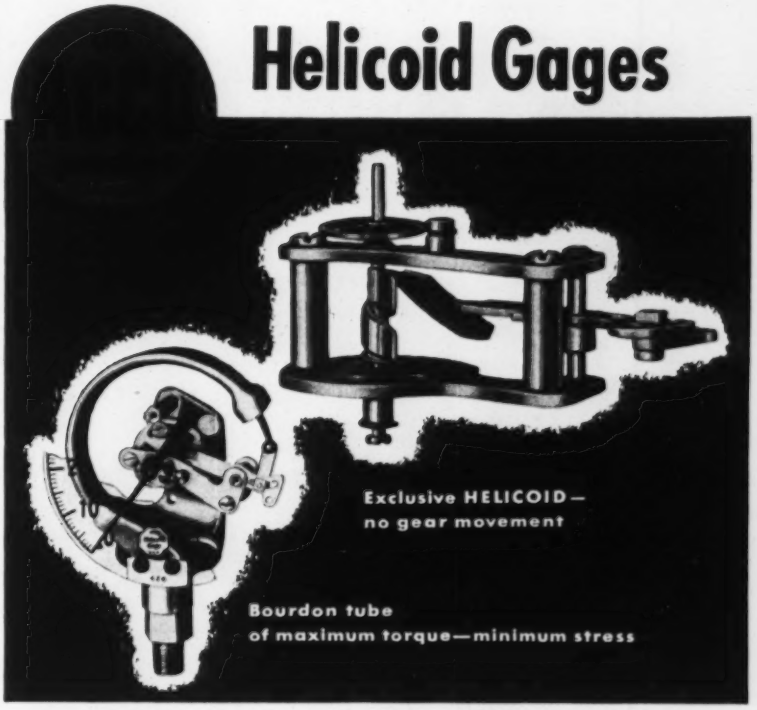
The company claims the sealed construction of the hoist makes it suitable for use under practically all atmospheric and operating conditions, and assures longer service life. Cement mills and foundries which operate under excessively dusty conditions, heat treating rooms, and industries with cold or wet exposures are suggested possible fields of use for the hoist.

The hoist has no protruding parts to snag on clothing, and a non-fouling hand chain guide prevents gagging of the hand chain and permits its use from any angle, The 5 to 10-ton models have six pocket sheaves, the 12 to 25-ton models, ten pocket sheaves. The sheaves are carried in and shrouded by steel castings.

Wet Dust Collector

Pangborn Corp., Hagerstown, Md., has announced the development of its type "CW-1" centrifugal wet dust collector said to be a high efficiency collector of countercurrent design and of tower type construction. The basic operational principle of the collector is the flow of ascending air or gas counter to the descending liquid, with performance greatly improved through more intimate interaction between the elements.

The collector consists of multiple patented wet impingement vane sections topped by a water entrainment vane section. The illustration shows four wet vane sections with a fifth section serving as a liquid eliminator. Capacity of the collector is proportional to the diameter, and the number of wet vane sections specified is governed by application requirements. Collector design has achieved sufficient flexibility to permit a considerable increase in air or gas and liquid without impairing collector action, according to company engineers.



Why HELICOID Costs Less Per Gage, Per Year

HELICOID Gages have many unique and exclusive features which result in enduring accuracy and savings in maintenance cost. They cost less per gage, per year.

Only HELICOID Gages, for instance, have the Helicoid Movement . . . a simple cam and roller design which has no gear teeth to wear out. Bourdon tubes used in HELICOID Gages are carefully designed to give maximum torque and minimum stress . . . promoting the greatest possible endurance life. They withstand many millions of pressure pulsations without stretching, leaking or cracking.

There is a HELICOID long-life gage to meet every type of pressure control requirement. Pressure ranges to 20,000 psi, vacuum or compound. Dial sizes: 3½", 4½", 6", or 8½". Dials may be black, white or radiant faces. They are supplied for wall or stem mounting, flush or panel mounting, or flangeless.

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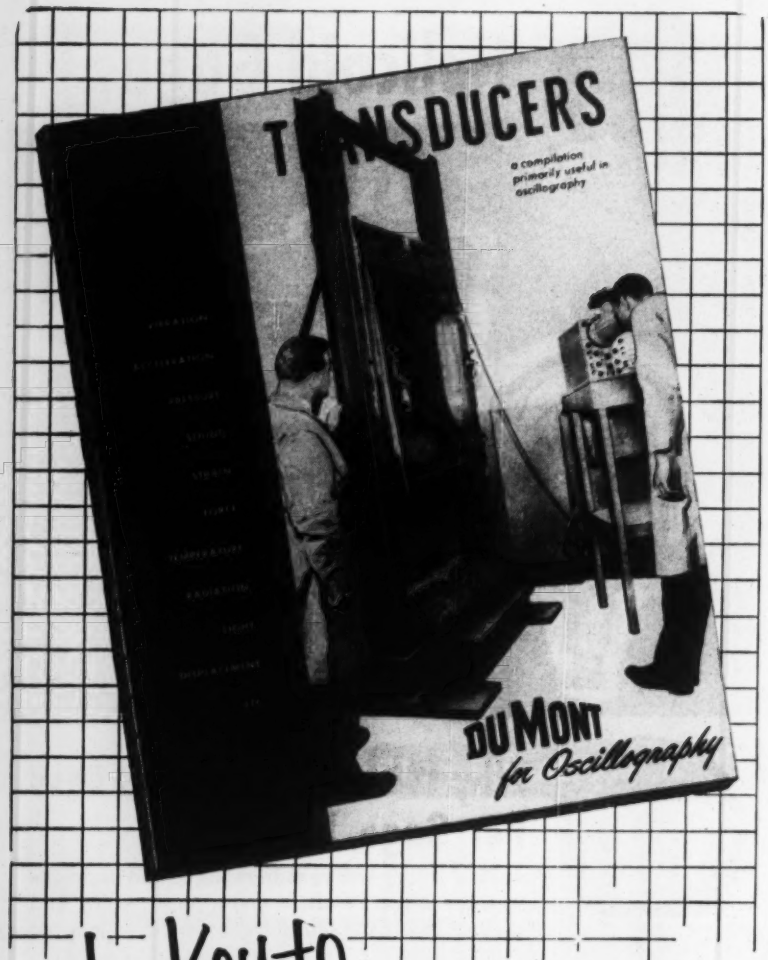

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In those applications where electrical potentials do not exist, fullest exploitation of the many advantages of cathode-ray oscillography depends upon the selection of the proper transducer.

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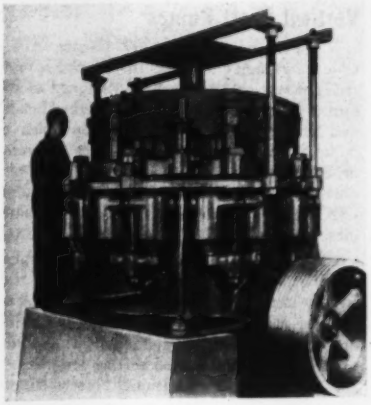

Gyradisc Crusher

Nordberg Mfg. Co. recently introduced the Gyradisc built to supplement Symons Cone Crushers and provide a medium for still finer reduction than that heretofore obtainable in conventional reduction machines.

The new method of communition employed in the Gyradisc, using the Gruender method of reduction, is a process of alternately impacting and releasing a thick mass of material, resulting, the company says, in the production of large tonnages of fine particles. Relatively large particles combined in an intimately mixed feed which is automatically distributed throughout the crushing chamber prevents packing of the mass and assures high output. Mixing and feeding are accomplished and controlled by the compound action of gyration and rotation of the feed distributor.

The Gyradisc is currently built only in the 54 in. size. Ideal feed is the open circuit product of a Symons cone crusher or equivalent product containing material minus 1 in., $1/2$ in., or $3/8$ in. with or without fines. It may, however, operate in closed circuit with fines separated by pneumatic or mechanical methods. According to the company, tests in actual installations, both metallic and non-metallic fields, have proved that the Gyradisc economically produces substantially greater tonnages of fines than most other methods of crushing.

Steam Traced Pipe

Unitrace, an integrally extruded steam traced aluminum pipe manufactured by Aluminum Co. of America, has been introduced as a solution to equipment problems of users of steam traced piping.

It is the result of joint engineering efforts by Alcoa and Hercules Powder Co.

In contrast to normal methods of heating lines by using an external steam jacket or steam tube to apply the necessary heat, Unitrace is produced so that the steam line is an integral part of the pipe. Extruded as a single unit from Alcoa 3S-F aluminum alloy, the new product is slightly oval in cross section because of the crescent-shaped steam passage adjacent to the product line.

KEEP INFORMED

NEW EQUIPMENT
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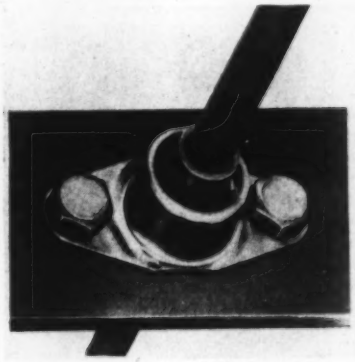
The size now available has the pipe dimensions of 2 in., Schedule 40 pipe.

Pre-formed insulation will fit Unitrace. In the case of the 2 in. pipe, the product is designed so that insulation for 2½-in. standard pipe will form naturally. When insulation is used, a smaller size can be used than with the older steam-jacketed piping. But because of improved efficiency, thermal insulation will be unnecessary in many cases, particularly where set quantities of process steam are allocated for tracing purposes.

The new piping is said to lend itself readily to shop fabrication of standard lengths. It can be formed easily using conduit tools.

Products suggested by the company as being well suited for use with Unitrace include naval stores, molten sulfur, ammonium nitrate solutions, glacial acetic acid, fatty acids, tar and pitch, and similar products normally requiring steam tracing or steam jacketing.

Unitrace is presently available in standard 2-in. pipe size without die charge. Mill stocks are maintained by Alcoa at convenient locations. Further information is available from Aluminum Co. of America, 720 Alcoa Bldg., Pittsburgh 19, Pa.



Ball Bearing Series

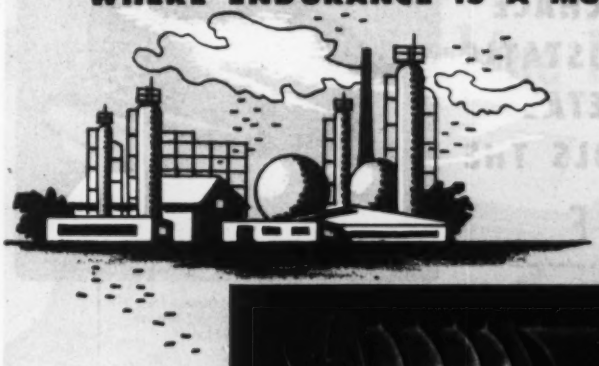
Nice Ball Bearing Co., Philadelphia, Pa., is now producing a new line of flange mounted radial bearings. These new assemblies, known as "6900" series, consist of a double composition sealed precision radial bearing and a flanged housing, or adapter, designed for flush mounting.

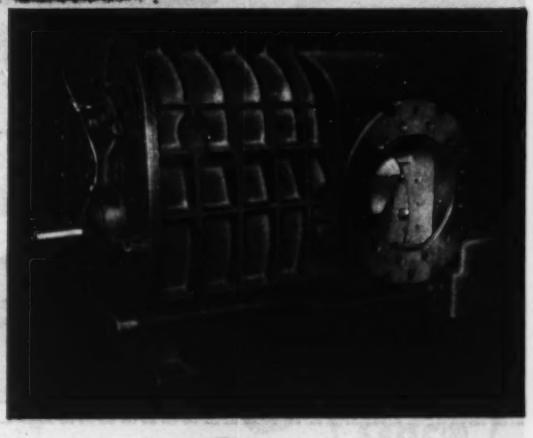
The housing is said to provide a secure, inexpensive means of bolting the bearing in place while two locking set screws position the bearing on the shaft. Series "6900" assemblies are recommended by the company for medium loads and speeds up to approximately 5000 rpm maximum.

They are available in inch standard shaft sizes ranging from ¼ to 1 in. and can accommodate a limited amount of angular misalignment.

Assemblies can also be provided with unground bearings for less exacting applications. These assemblies are normally produced to order.

WHERE ENDURANCE IS A MUST...





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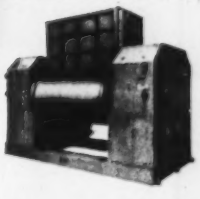
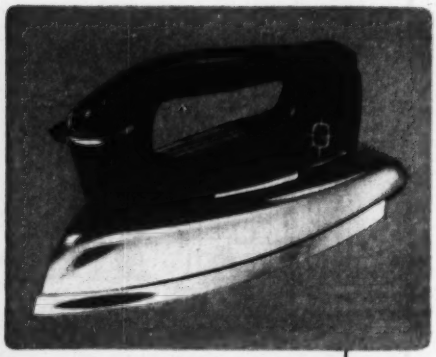


Read Standard also manufactures a complete line of chemical mixers for laboratory and industrial use. For information write, Read Standard Corporation, York, Pennsylvania.

HOW CHACE THERMOSTATIC BIMETAL CONTROLS THE G-E VISUALIZER IRON



Product of General Electric
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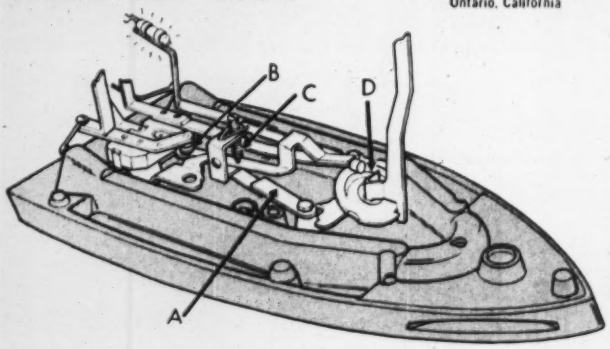
Ontario, California



CHACE Thermostatic Bimetal meets the exacting specifications for the new General Electric Automatic Visualizer Iron Model F-33. Features of this beautiful design are its Visualizer Fabric-Dial, automatic signal light, light weight of less than 2½ pounds and extra-large soleplate.

The controlling element (A) is composed of two types of thermostatic bimetal welded together. The heavier gauge and the slower of the two to respond is mounted on the soleplate and bends downward as the temperature of the soleplate increases, breaking the circuit at the contacts (B). The lighter and more responsive section of the element carries the mounting bracket for the insulated adjusting screw (C). The faster action of this section causes a more rapid make and break and a steady control of heat for various fabrics. When the points are closed, the safety light flashes on for a few seconds while the current brings the plate up to the correct temperature. Turning the Visualizer cam (D) raises and lowers the ceramic-tipped contact arm; the narrower the gap, the longer the current flows through the plate.

Chace furnishes thermostatic bimetal in 29 types, in strip, random length coils or in complete elements fabricated and assembled to your specifications. Before development of your new controlling, indicating or protecting device, read our booklet, "Successful Applications of Chace Thermostatic Bimetal," containing valuable engineering data. Write for it today.

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Thermostatic Bimetal
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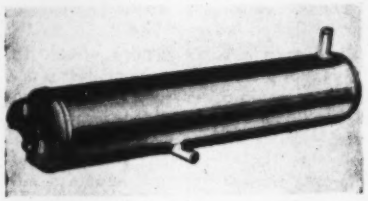
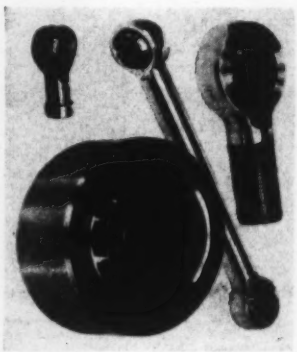


Freon Condensers

A new line of ASME constructed and stamped extended surface Freon condensers has been announced by Bell & Gossett Co., Morton Grove, Ill.

The new line of condensers consists of two styles of units. The model "CFG" shell and coil condensers are designed to fill the need for a low cost condenser in small tonnage installations, the company says. It is available from factory stock in 2, 3, 5, 7½ and 10 ton sizes.

The model "CRF" condenser is a straight tube unit with removable heads, constructed and stamped in accordance with ASME unfired pressure vessel code. It is available from factory stock in 2 through 25 ton sizes. Catalog information and selection data are available from the company.



Spherical Bearing

A new design conception for spherical bearings which allows heavier loads and a wider range of usable materials, is announced by the Delron Co., Inc. The new bearing is produced as two pieces by a method which requires no swaging operations for assembly.

The company points out that elimination of the usual swaging provides better surface conformation between ball and race, resulting in greater bearing area, and heavier allowable radial and axial loads. The new design can be used in a wide variety of materials, rather than being limited to materials capable of deformation.

The company's spherical bearing is now being manufactured in many configurations including rod ends, and sizes up to No. 16. The bearing can be produced in other sizes as required. Details and recommendations for specific applications, are available from the Delron Co., Inc., Bearing Div., 5224 Southern Ave., South Gate, Calif.

KEEP INFORMED

NEW EQUIPMENT
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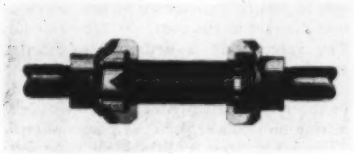
New Compressor

A packaged air compressor in the 75-100 hp range that approaches the good efficiency and economy of larger, more powerful slow speed compressors has just been introduced by Ingersoll-Rand Co., 11 Broadway New York 4, N.Y.

The new machine, known as PHE, is an opposed-cylinder, balanced design driven by a direct connected, induction motor. It is a packaged, ready-to-run, heavy duty unit, arranged in single or multi-stages. The basic design is a two-stage unit for 80-125 psi but other cylinder arrangements are available for higher pressures or for pumping vacuums.

The PHE requires very little floor space, a simple foundation and a minimum of piping and connections. It is suitable for factories, foundries, railroad shops, mines, powerhouses and large construction jobs.



Water-Saving Control

A water line flow volume control designed to maintain one set flow rate regardless of variable inlet pressures is announced by Hays Mfg. Co., 816 W. 12th St., Erie, Pa.

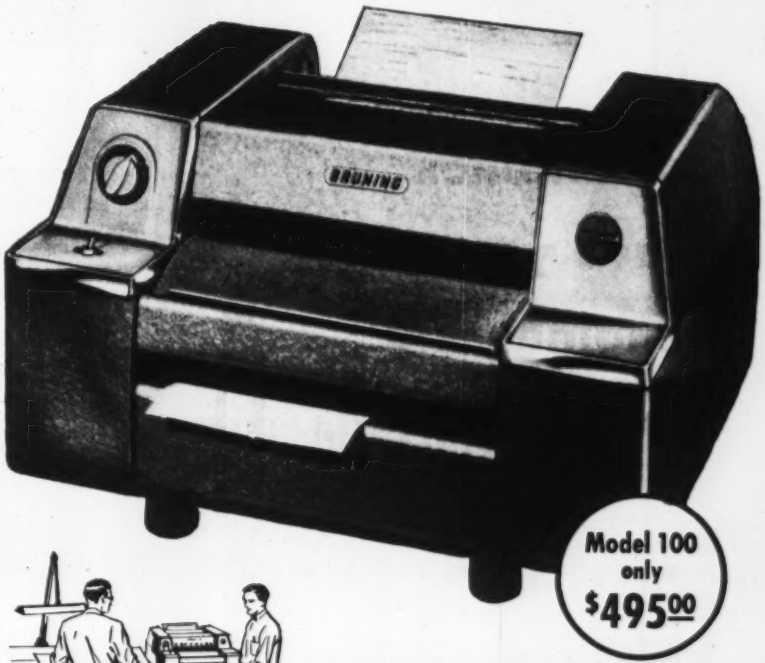
The control will automatically compensate for surges in line pressure, and pressure drop is preset to deliver one constant rate anywhere between .2 gpm and 14 gpm according to the engineers. It is said to maintain operating accuracy of 10 per cent within the variable range of 15–150 psi. Called "Mesurflo," it is available in 1/4 in., 3/8 in., and 3/4 in. pipe sizes.

Precision Pressure Balance

Fast, accurate, non-manual measurement of precision pressures is said to be accomplished by a precision pressure balance introduced by Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 8, Calif. The new instrument replaces mercury manometers. The company claims balance Type 37-103 provides a laboratory standard for precise calibration of pressure pickups with accuracy comparable to the highest quality manometers. A visual, digital readout counter with digits to 1000 makes immediate readings possible.

The instrument is designed so that readings may be held when required or attached to electrical tabulating devices through a built-in electrical analog d-c output of 10 v. The pressure pickup is engineered to make possible readings of differential pressure, gage pressure, and absolute pressure. The amplifier may be used with various ranges of pressure sensing pickups. A 10-ft cable enables readings to be taken at a distance from the amplifier.

Here's the Helper Your Big Reproduction Machine Needs!



Specification Sheets, Check Prints and Engineering Changes Reproduced When You Want Them!

It just isn't common sense, is it, to tie up your big reproduction machine running pre-cut sheets? And now you don't have to. There's a new, economical unit that you can use for just this purpose.

The new Copyflex Model 100 has an 11-inch printing width. It operates up to 12 feet per minute and reproduces up to 300 copies in one short hour at a cost of less than 2¢ each.

Like all Bruning Copyflex machines, the Model 100 is clean, quiet and odorless . . . no ammonia or ozone vapors. No installation problems. It is so compact you can locate it anywhere and anyone can operate it.

If you are tying up your big reproduction machine running pre-cut sheets, let us show you how the new Copyflex Model 100 can save you time and money. Mail us the coupon below for full particulars of this new Copyflex.

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Copies anything drawn, printed, written, or typed on ordinary translucent paper—in seconds.

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Please send me more information about the Bruning Copyflex Model 100.

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complete hanger assemblies save your engineering time

For complete information . . . write for your copy of Bulletin No. 54.

You can save many hours of engineering time and speed up your specifications by using Blaw-Knox overhead roller assemblies, rigid hanger assemblies, functional spring hangers with the patented *internal swivel action*, and vibration eliminators.

Each is a complete unit designed for a specific purpose. Constructed to comply with the "code for pressure piping" requirements. Available in types and sizes to meet varying conditions.

And each is ready to install. So you also eliminate expensive cutting, threading and assembling in the field.

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PIPE HANGERS

Complete line of functional spring hangers • rigid hanger assemblies • overhead roller assemblies • supports • vibration eliminators . . . plus complete prefabricated power piping systems

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Plastic Valve Body

A tough, lightweight, rubber-plastic valve body with 3-in. diam designed to provide process industries with a new weapon in the solution of their piping problems has been developed by United States Rubber Co., Rockefeller Center, New York 20, N. Y. The valve body is made of a styrene copolymer called Uscolite.

The plastic was adapted to a diaphragm valve by the rubber company's mechanical goods division in cooperation with the Hills-McCanna Co. of Chicago. Also announced by the division is a complete line of three and four-in. pipe fittings made of the same material. Heretofore the largest valve and fittings available were 2 in. in diam. Pipe sizes range to diam of 6 in.

Due to the high degree of chemical resistance and low moisture absorption of the rubber-plastic blend, the valve body will not contaminate the materials being handled nor will it absorb ingredients of one batch for transmission to the next, the company says. The valve body is described as odorless, tasteless and non-porous, thus bacteria-proof.

The valve and pipe fittings are of one-piece, homogeneously-molded construction, having no welds or joints at points of stress. They are made to withstand the same working pressures and temperatures as the corresponding size extra heavy Uscolite pipe. Working pressures range to 150 psi and temperatures to 170 F.

Magnetic Clutches, Brakes

A new line of magnetic clutching and braking devices has been developed by Ford Instrument Co., Div. of the Sperry Corp., for application in computers and mechanisms that require a high order of clutching and braking accuracy. The new units include a single clutch, a double clutch, and clutch brake.

Company engineers say the units are designed to provide continuous operation, immediate release upon de-energizing, extremely rapid "pull-in," negligible steady state control current requirement, wide environmental range, miniature size, and light weight. They are designed with a definite neutral position for the friction disk which is said to preclude dragging on the friction face regardless of mounting position.

The units are made with anodized finish, fungus-inert materials, and encapsulated windings. They are constructed of corrosion resistant materials. Operating temperature range is -65 to $+165$ F.

With the incorporation of a telephone-type relay, maximum response time of all three units is 6 millisec or less. Without a relay, response time is slightly higher. They are designed for a maximum torque of 16 oz-in., and for intermittent duty at speeds to 1000 rpm. Life expectancy is based on a minimum of 200,000 cycles at 30 rpm with load inertia of 1 oz-in. Moment of inertia of input shaft is 0.30 oz-in.^{2}; of output shaft is 0.21 oz-in.^{2}. Input and output gears are designed to customer specifications.

KEEP INFORMED

NEW EQUIPMENT
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Carrier Amplifier

Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 8, Calif., has introduced a 4-channel carrier amplifier which has a flat frequency response from 0 to 3000 cycles. The type 1-127 amplifier has a frequency range three times that available in any similar instrument, according to the company, and the aircraft, guided missile and atomic energy fields may find the amplifier system useful for reproducing outputs of resistance or reluctance type transducers.

The instrument contains a regulated power supply, 20-kc oscillator, 4-carrier amplifiers with associated bridge balancing and demodulator circuits, control and metering system, and a calibrating system. For nominal amplifier sensitivity, a one mv modulation signal causes full scale output of plus or minus 50 ma. The amplifier is provided with a gain control to adjust for full scale when an input of one mv is applied with any source impedance from 60 to 1000 ohms.

White Print Machine

A new, high capacity whiteprint machine scheduled to go into production this fall has been announced by Ozalid, a division of General Aniline & Film Corp., Johnson City, N. Y.

Called the Ozalid model 800, the new machine will reproduce translucent engineering drawings and business forms up to 42 in. wide at speeds up to 30 fpm. It will cost $3250.

The machine which will offer front or rear delivery, will be continuous in operation with prints going directly from feedboard through exposure and development without having to be re-handled. A new jet type atomizer forces ammonia under pressure into a vaporizing tank, assuring complete and full development while waste is held lower than was previously considered possible.

An electronic speed drive is said to permit instant changes to any speed from 8 to 30 fpm, and a wattage stabilizer maintains constant printing speeds by compensating for voltage fluctuations within the 200–240 v range.

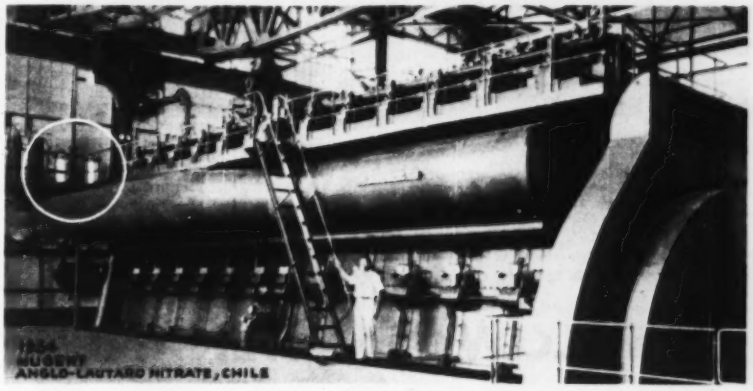
Optional accessories, available at additional costs, include a rear stacking device and a constant torque motor to take up long prints or roll stock. A folder describing the machine is available from the company.

Range Selector

A new range selector made by All American Tool & Mfg. Co., 8027 Lawndale, Skokie, Ill., originally developed as an automatic frequency control device for vibration fatigue test machines, has been made available to equipment builders.

Applied to a particular machine, the range selector can be set so that a cam would turn a half revolution, quarter or eighth revolution or any other fraction. The unit can be adapted for use with V-belt speed changing units or any cam actuated mechanism wherein variable rotation is required.

MOST POWERFUL DIESELS



...rely on NUGENT FUEL OIL FILTERS!

● The giant diesel shown above is one of two, 9,600 hp. Nordberg engines installed for the Anglo-Lautaro Nitrate Corporation at their plant in Coya Sur, Chile. The diesels are the most powerful single units ever built in the Western Hemisphere.

Included as original equipment on each of these engines is a Nugent #4L4 twin transfer filter (shown in circle above) for preliminary fuel oil filtering and a Nugent #4L Duplex fuel oil filter (not visible) to provide the final filtering. The Coya Sur installation is another example of Nugent filters being installed as original equipment by a leading diesel manufacturer.

Size for size, Nugent filters of the above type offer greater filtering area than any other filter on the market. In addition, the lubricating oil filters make possible a choice of full flow or by-pass with the same unit. Simple piping makes installation no problem.

No matter what the size of your own diesel power supply—no matter where it is installed, there is a Nugent fuel or lube oil filter to meet your needs. Write for complete information

◀ Close-up of a Nugent #4L4 filter of the type used for fuel oil transfer on the giant diesels at Coya Sur. Recharges are inexpensive and simple to replace.

▶ Nugent duplex filter of the type used for final fuel oil filtering on the diesels at Coya Sur. By actual test, removes 99.8% of all foreign solids from fuel oil.

Wm. W. Nugent & Co., Inc.
409 N. Hermitage Ave. ● CHICAGO 22, ILLINOIS

OIL FILTERS, OILING AND FEEDING SYSTEMS, TELESCOPIC SHAFTS, OILING DEVICES, SIGHT FEED VALVES, FLOW INDICATORS

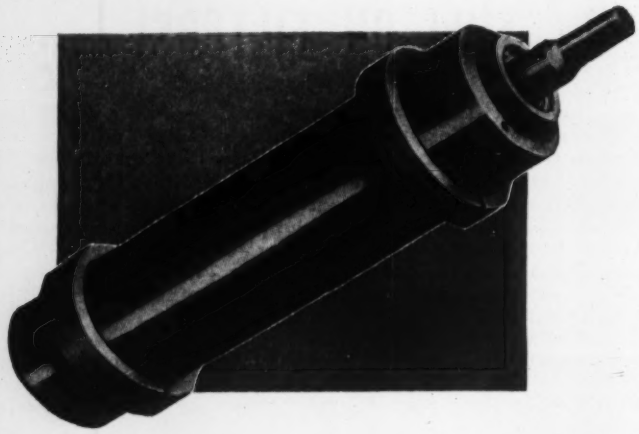
Boiler Line Extended

Cleaver-Brooks Co., 326 E. Keefe Ave., Milwaukee, Wis. announces the extension of its CB line of boilers to include units of 50, 60, 70 and 80 boiler hp capacity. The new self-contained boilers are available for commercial, industrial and institutional installations requiring steam or hot water boilers for processing or heating.

The new models burn gas or oil at maximum efficiencies and can be converted from one fuel to another in less than a minute, the company claims. The boilers are constructed in one integrated unit. All operating and safety controls are easily accessible with burner components mounted on the front head. Information is contained in bulletin AD-135 available from the company.

FOR LOW MAINTENANCE

Westinghouse Type "A" Pneumatic Cylinders



● Maintenance is no problem with these streamlined Westinghouse Type "A" Pneumatic Cylinders. They have only a few wearing parts, and *all* parts are strong and durable to assure long life in hard service. A wrench grip on the push rod makes servicing easy and adds to the life of the rod.

Westinghouse Cylinders are built with or without cushioning. They are light, compact and fast acting.

Standard construction is steel but for corrosive uses, brass bodies and stainless steel push rods can be supplied.

Diameters run from 1½" to 10" with strokes from 1" to 42"—and longer if push rod is in tension. Units can be foot-mounted, flange-mounted, or pivot-mounted.

Write for booklet 9308-2

Westinghouse Air Brake
COMPANY

INDUSTRIAL PRODUCTS DIVISION WILMERDING, PENNSYLVANIA

Pneumatic cylinders, valves, engineered pneumatic systems and air control devices of all kinds.

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Distributed in Canada by: Canadian Westinghouse Co., Ltd., Hamilton, Ontario

Thermostat Developed

A thermostat actuated by a compact "Power-Pill" thermal unit for use in pressurized cooling systems of automobile and truck engines, and general industrial usage has been announced by the Fulton Sylphon Div. of Robertshaw-Fulton Controls Co. The unit is charged with a special wax-like composition instead of conventional volatile liquids or gases. The wax compound melts as the water in the engine cooling system begins to heat up and solidifies again upon cooling. A pronounced increase in volume of the wax-like charge on melting serves to actuate the thermostat valve, allowing water to circulate through the radiator for cooling.

Additional information may be obtained from the company, Box 400, Knoxville, Tenn.

Gas Engine

Addition of a new one cylinder gas engine to its Power Chief series of small diesel prime movers is announced by Nordberg Mfg. Co., Milwaukee, Wisc. The engine is built as a low cost, medium speed unit for oil field service as well as for any small power application where natural gas is advantageously available.

It is rated at from 9 to 18 maximum brake horsepower within an operating speed range of 800 to 1800 rpm. It has a 4½ inch bore and 5¼ inch stroke and is an extra heavy duty, vertical, spark ignition four-cycle engine. Currently produced only in the single cylinder model, it is available as a complete, self contained, ready to operate power unit with clutch power take-off and as a "packaged" generator set producing up to 10 kw. Major parts of the company's gas and diesel engines are identical permitting conversion of one to the other at very reasonable cost.

The gas engine is designed to start and operate efficiently on natural gas or gasoline. Engine ignition system is furnished complete and includes magneto with impulse coupling, ignition cable and spark plug. A speed regulating governor, gear driven from the crankshaft, regulates fuel to the combination natural gas-gasoline carburetor in accordance with engine load requirements.

GIVE ENOUGH
SOON ENOUGH

Ring Dispenser

A new dispenser which automatically feeds three Waldes Truarc crescent or "E"-shaped retaining rings at one time is being introduced by Waldes Kohinoor, Inc., Long Island City, N.Y.

Intended primarily for use with assemblies in which more than one ring must be mounted, the new dispenser has been designed to hold three rods of stacked retaining rings mounted side by side on a standard Truarc dispenser base. The rings are withdrawn by means of a special applicating tool which has three fork heads set into a standard applicator handle. Both the dispenser and applicator must be engineered for individual applications.

According to the company, the unit makes possible savings of time and motion which speed assembly with the rings and lessen operator fatigue. By feeding three rings simultaneously, the unit is said to eliminate four motions which would be required with a single-stack dispenser: inserting and withdrawing the applicator twice for each of two rings.

2-Switch Governor

Synchro-Start Products, Inc., Skokie, Ill., has announced the addition of a two-switch governor to its line of speed sensitive switches. Also announced is the redesign of its line of governors to give still longer life and better accuracy at no increase in prices. The new unit contains two snap action switches rated at 10 amp 110 v a-c, and can be used for either opening or closing circuits at any rpm over 350. Each switch is individually adjustable up to 2000 rpm above specified set speed.

On the redesigned governors, the knurled adjusting ring has been eliminated and replaced with three set screws in angle slots, making possible an adjustment range of 20 per cent increase or decrease. The speed sensitive switches are available in two body designs. The GS series is adaptable to standard distributor take-off to accommodate gear or coupling drives and the rotating parts run in oilless bronze bushings. The GH body design is for standard SAE tachometer drive and runs in oilsealed ball bearings.

Mold Conveyor

Jeffrey Mfg. Co., Columbus 16, Ohio, has announced a new universal mold conveyor capable of smooth mold handling up and down inclined planes as well as on the level.

It features articulated connections between the cars and internal type takeups. It is said to require no lubrication because it is equipped with permanently lubricated ball bearings and oil impregnated bushings. The cars are made up of a rugged malleable iron chassis, chilled-iron, flangeless wheels, and easily changed tops which can be either steel, cast iron, roller, or hinged for automatic discharge. All moving parts below the car tops are fully protected from sand, shot or runouts by means of specially designed shields.

Here is How
CATERPILLAR®
uses
BARCO
Swivel Joints

1. **VERSATILE.** Barco Swivel Joints solve many piping problems where leakproof flexible connections are needed to allow for movement, overcome misalignment, and guard piping against vibration, strain or shock.
2. **NO BINDING.** Up to 10° side flexibility with 360° swivel movement. Low torque; easy turning. No lubrication required.
3. **MANY STYLES AVAILABLE.** For pressures to 3,000 psi; temperatures to 600° F. Sizes ⅜" to 2".
4. **PRESSURE-SAFE; FIRE-PROOF.** Joints have high safety rating and develop no dangerous pressure thrust.
5. **COMPACT.** Easy to install. Require less space than other types of flexible connections.

ASK FOR BULLETIN No. 265A

—*on* HYDRAULIC CONTROL *Lines*

■ THIS photograph illustrates the use of a *self-aligning* Barco Swivel Joint on the hydraulic connection between a Caterpillar Diesel DW10 Tractor and W10 Wagon. The male end of the joint screws directly into the king pin (arrow) in the main hydraulic pressure operating line between the tractor and the wagon. It is used at the pivot point in place of a long length of hose. At this point, it provides complete flexibility for turning and sideways movement of the wagon without placing any strain on the 300 psi pressure piping.

Rugged Barco Swivel Joints are ideal for this kind of service because they stay leakproof and require no lubrication or attention over long periods of time. This is one of thousands of different applications where Barco joints are used to solve piping problems in industry. *When you need flexible piping connections on machinery, check with Barco.* Worldwide Sales and Service. BARCO MANUFACTURING CO., 521K Hough St., Barrington, Illinois.

BARCO

THE ONLY TRULY COMPLETE LINE OF FLEXIBLE BALL, SWIVEL, SWING AND REVOLVING JOINTS

Everyone knows this
is a sign of refreshment...

And smart gear users know
this CINTI is the sign of
the best in custom made gears.

CINTI "Gears... Good Gears Only"

THE CINCINNATI GEAR CO. • CINCINNATI 27, OHIO

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ENGINEER
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Systems engineers conduct studies to determine operational requirements . . . create and synthesize military equipment concepts . . . guide development of new integral elements . . . conduct evaluation programs to determine operational effectiveness.

You may qualify! Professional *ability* to create and analyze over-all complex systems and *experience* in electronic or electro-mechanical systems engineering required.

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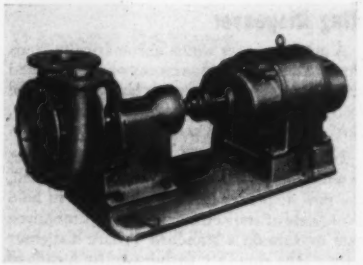
KEEP INFORMED — NEW EQUIPMENT, BUSINESS NOTES, LATEST CATALOGS



Centrifugal Pumps

A new line of centrifugal pumps designed especially for handling corrosive liquids and slurries is announced by Goulds Pumps, Inc., Seneca Falls, N.Y.

The pumps, designated as the Fig. 3715 series, are available with the entire fluid end in 316, Gould-A-Loy 20, or 304 stainless steels, all iron, all bronze, bronze fitted, all iron with stainless trim, or all bronze with stainless trim.

Fig. 3715 pumps are of support-head construction, with the support cast integral with the bearing housing. The maximum liquid temperature limitation for operation of the pump has been raised to 350 F with provisions for water cooling of the support head and quenching of the gland. Single or double mechanical seals can be provided if desired, and they also can be quenched.

The stuffing box is on the suction side of the impeller, and so is under suction pressure only to insure long packing life, and keeps leakage at a minimum. Wide openings in the support head provide easy access to the stuffing box and gland.

The pump is built in nine sizes, ranging from $^3/_4$ to 3 in., providing capacities up to 720 gpm, and heads to 200 feet. The company has given particular attention to standardization of interchangeable parts, making it possible for users of the pumps to keep spare parts inventories at a minimum. Additional details, including performance data, are found in Bulletin 725.4, which can be obtained on request from the company.

Pressure Gaskets

A series of rectangular "O" ring rf and pressure gaskets for use with single or dual waveguide contact flanges has been announced by Airtron, Inc., 1105 W. Elizabeth Ave., Linden, N. J.

The single gaskets and their associated pressurized contact flanges were designed to meet the increased demand for more compact rf and pressure tight waveguide connections without loss in electrical performance. They have a circular cross section which provides an airtight seal upon compression. To assure an adequate rf seal, a silver plated copper strip is mounted on the inner periphery of the gasket. This arrangement is said to allow for a continuous electrical contact along both flange surfaces without disrupting the air seal.

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Studmount Air Cylinders

The A. K. Allen Co., 57 Meserole Ave., Brooklyn 22, N. Y., announces the introduction of Allenair studmount cylinders. The cylinder has a 1¼ bore and is available in inches and half-inches of stroke from 1 to 6 in. maximum.

Cylinder is double acting and features brass heads, nickel plated and screwed into the honed and "Copper-brited" cylinder tube. The piston rod is stainless steel and is both screwed and brazed to the brass piston.

Standard "O" rings are used for sealing both the piston and the piston rod. Flange or foot mounts as well as a piston rod clevis are available.

BUSINESS NOTES

Worthington District Office

Worthington Corp., announces a new location for its Twin Cities district office, at 807 Thirteenth Ave., S. Minneapolis, Minn.

Safety Tool Distributor

Ampco Metal, Inc. announces the appointment of the Davis Emergency Equipment Co. of New England, 130 W. Emerson St., Melrose 76, Mass., as a class A safety tool distributor.

Bethlehem Licenseeship

The National Bond Insulators of Bethlehem, Pa., have accepted an Insul-Mastic Licenseeship to sell and apply the line of reinforced asphaltic coatings marketed by the Insul-Mastic Corp. of America. In the insulation field, these coatings are used as a weather and vapor barrier over insulation.

New Sales Office

To serve industrial customers in Ann Arbor, Mich. and surrounding areas, the Bellows Co. of Akron, Ohio has established a new sales office at 330 Municipal Court Bldg., Ann Arbor.

The company manufactures and sells controlled air power devices for pushing, pulling or holding materials during machine work.

Named Distributor

Industrial Tool and Supply Co., San Jose, Calif., has been named an authorized distributor for Carboloy Dept. of General Electric Co., Detroit, Mich. The organization will carry the department's entire line of standard cemented carbide tools and blanks, carbide-tipped masonry drills and diamond wheel dressers.

For Consulting Engineers Turn to Page 146

BIDDLE *Instrument News*

MEGGER® ELECTRICAL INSULATION TESTERS

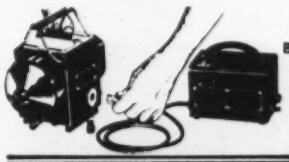
Hand—Rectifier—or Combination Operation—

Ratings up to 2000 Megohms and 1000 Volts D-C

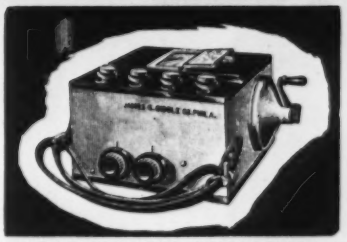
HAND CRANK MEG TYPE of Megger Insulation Tester is a reliable field instrument, light, sturdy, with a constant-voltage type generator—no dependence on batteries or other current supply. By far the most popular instrument among electrical plant maintenance men. Easy to use—easy to read—and rugged in constant services.

RECTIFIER OPERATED Meg Type of Megger Insulation Tester simply plugs into a convenient outlet. Portable or flush bench-mounted. A dependable production or inspection instrument. Quick, easy readings speed up otherwise costly tests.

DUAL-OPERATED MEG TYPE of Megger Insulation Tester may be operated by hand or rectifier. Excellent solution for those requiring a versatile instrument for field and bench use.



Write for BULLETINS 21-45 M 21-46 M



INSULATION TESTER & WHEATSTONE BRIDGE in ONE EASILY PORTABLE INSTRUMENT

Measures Electrical Resistances From a Fraction of an Ohm up to 1000 Megohms

Affords the facility of:

- **A Wheatstone Bridge** for measuring conductor resistance of coils, resistors and circuits.
- **A Megger Direct Reading Ohmmeter** for measuring electrical insulation resistance (ohm and megohm scales).
- **A Varley Loop Feature** for locating faults on wires (optional).

This Bridge-Meg weighs only 15 lbs. and is completely self-contained with its own constant-voltage generator—no need to be dependent on batteries or other suitable test current.

Why burden yourself with two instruments when you can have the facilities of two for little more than the price of one in one compact, sturdy case. For complete details and prices write for BULLETIN 21-60 M.

IF YOU MEASURE SPEED • • • YOUR BEST BET IS BIDDLE

Average Measuring RPM or FPM Jagabi® Speed Indicator

Dr. Horn Tachometer

Jagabi® Tachometer

Instantaneous Speeds or Variations in Speeds. Write for BULLETIN 35-M

Frahm® Resonant Reed Tachometer

Quick Accurate Readings with Safety

BULLETIN 31-M

B-914

JAMES G. BIDDLE CO.

- ELECTRICAL TESTING INSTRUMENTS
- SPEED MEASURING INSTRUMENTS
- LABORATORY & SCIENTIFIC EQUIPMENT

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ARE YOU SEARCHING FOR
HIGH PERFORMANCE BEARINGS?

GRAPHALLOY

OIL-FREE
SELF-LUBRICATING
BUSHINGS

Work Where Others Won't!

EXCELLENT DURABILITY • CONSTANT COEFFICIENT OF FRICTION • APPLICABLE OVER A WIDE TEMPERATURE RANGE — EVEN WHERE OIL SOLIDIFIES OR CARBONIZES **• OPERATE DRY, OR AT HIGH SPEEDS SUBMERGED IN WATER, GASOLINE OR OTHER LIQUIDS • EXCELLENT FOR CURRENT-CARRYING BEARINGS**

GRAPHALLOY materials are also in wide use for oil-free, self-lubricating piston rings, seal rings, thrust washers, friction discs, pump vanes, etc.

Other Graphalloy Products

For applications requiring low electrical noise, low and constant drop, high current density and minimum wear. Used for SELSYNS, DYNAMOTORS, SYNCHROS, ROTATING STRAIN GAGE pick-ups and many other applications. Brush Holders and Coin Silver Slip Rings also available.

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KEEP INFORMED — NEW EQUIPMENT, BUSINESS NOTES, LATEST CATALOGS

Acquires Tube Company

Burroughs Corp. has acquired Haydu Brothers of New Jersey, Plainfield, N. J., manufacturers of electronic tubes and components. The company will continue its operations under George K. Haydu, formerly president, who has been named general manager.

The Haydu Brothers plant will provide specialized manufacturing facilities needed for the production of new type vacuum tubes and other electronic components developed in the course of Burroughs extensive research activities in the electronic field.

Midwest Representative

Librascope, Inc., and Geo. A. Philbrick Researches, Inc., have appointed Askania Regulator Co., Chicago, as their Midwestern representative.

Librascope, Inc. produces computer components and specializes in the custom design of computing systems. Geo. A. Philbrick Researches, Inc. manufactures a line of electronic analog computers.

Adds 3 Distributors

Morse Chain Co. announces the following new distributors: Manufacturers Equipment and Supply Co., Flint, Mich.; Schuman Steel Products Co.., Bellingham, Wash.; Jack Lee Machine and Supply Co., Attalla, Ala. All firms will handle the complete line of Morse products including roller and silent chain drives and sprockets, cable chain, flexible couplings, driveshafts and clutches.

Names Representative

Taft-Peirce Mfg. Co., Woonsocket, R. I., announces that, the Cowan Supply Co., 124 Walker St., S. W., Atlanta, Ga., will be its manufacturer's agent for the state of Georgia. The company will handle Taft-Peirce's standard lines of gages, magnetic chucks, and toolroom equipment.

General Radio Branch Office

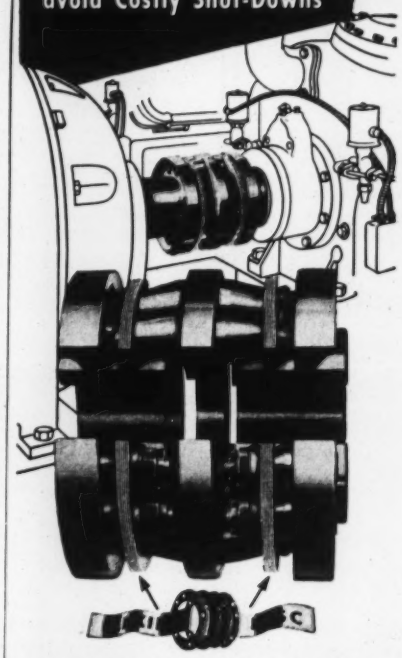
General Radio Co., Cambridge, Mass., has opened a branch engineering and sales office at 8055 Thirteenth St., Silver Spring, Md. Through this office technical and commercial information can be furnished promptly, and aid given in the selection of equipment to meet specific measurement problems.

Moves Detroit Office

The Graton and Knight Co., Worcester, Mass., announces the opening of a new Detroit branch office at 16146 Wyoming St. This office was formerly at 1627 W. Fort St. The new office will also serve as branch office for International Packings Corp., Bristol, N. H., a subsidiary.

The full line of industrial leather products manufactured by the company will be handled out of this office as will the leather and synthetic rubber packings, oil seals, and molded products manufactured by International Packings.

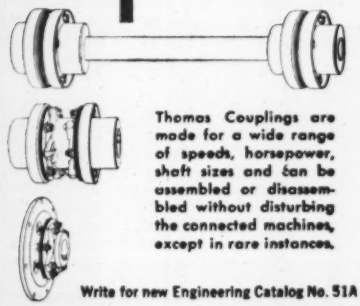
Specify THOMAS ALL METAL
FLEXIBLE COUPLINGS
for Power Transmission to avoid Costly Shut-Downs



Patented Flexible Disc Rings of special steel transmit the power and provide for parallel and angular misalignment as well as free end float.

DISTINCTIVE ADVANTAGES

FACTS	EXPLANATION
NO MAINTENANCE	Requires No Attention. Visual Inspection While Operating.
NO LUBRICATION	No Wearing Parts. Freedom from Shut-downs.
NO BACKLASH	No Loose Parts. All Parts Solidly Bolted.
CAN NOT "CREATE" THRUST	Free End Float under Load and Misalignment. No Rubbing Action to cause Axial Movement.
PERMANENT TORSIONAL CHARACTERISTICS	Drives Like a Solid Coupling. Elastic Constant Does Not Change. Original Balance is Maintained.



Thomas Couplings are made for a wide range of speeds, horsepower, shaft sizes and can be assembled or disassembled without disturbing the connected machines, except in rare instances.

Write for new Engineering Catalog No. 51A

THOMAS FLEXIBLE COUPLING CO.
WARREN, PENNSYLVANIA, U.S.A.

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Boiler Equipment

Cleaver-Brooks Co., Milwaukee, Wis. announces the appointment of the Harold R. White Company, Baltimore, Md. as manufacturer's representative for the sale of boiler equipment. Located at 3600 Fourth St., Arundel Federal Building, Baltimore, Md., its territory will include Washington, D.C., western Maryland, northern Virginia and the counties of Berkeley, Jefferson and Morgan in West Virginia.

Among its products are oil, gas and combination gas/oil fired stationary boilers, mobile steam boilers, thermo-compressors, evaporators, distillation equipment and industrial gas and oil burners.

LATEST CATALOGS

Sub-Plate Hydraulic Valve

The new line of Rivett sub-plate mounted, solenoid operated hydraulic valves is described in Catalog No. 260 published by Rivett Lathe & Grinder, Inc., Brighton 35, Boston, Mass. Featured in the catalog are JIC diagrams showing flow operations under all types of action for every one of the 14 piston designs in which the new valve is offered. Cutaway illustrations of the scalloped spool design show how the new 3000 psi valve is shock-resistant. Other notes and data necessary for individual circuit requirements are included.

Stainless Alloys

A new technical booklet consisting of eleven reference sheets covering the major stainless alloys has been announced by the Cooper Alloy Fdy. Co., Hillside, N. J.

Data on chemical composition, mechanical and physical properties, resistance to major corrosive solutions, machinability, heat treatment, and weldability is given for each alloy, along with the equivalent ACI, AISI, SAE and ASTM designations.

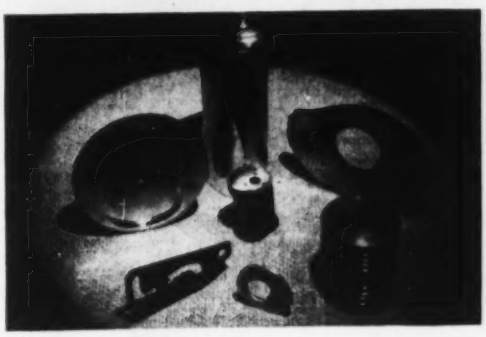
Investment Casting

A new 12-page booklet—"Investment. . . For Economy. . .For Performance"—has been published by the Hitchiner Mfg. Co., Milford, N. H., to tell the story of precision investment casting and its advantages and limitations. The steps involved in investment casting are described clearly. The company makes the point that when all cost factors—amortization of tools, cost of secondary machining or finishing operations, assembly—are considered, the true cost of investment castings is often very low in either large or small quantities.

Pictures taken throughout the Hitchiner plant show precision investment casting methods from the precise building of dies to the careful inspection and gaging of the finished casting against order prints.

Write to the Hitchiner Mfg. Co., 1249 Farmington Ave., West Hartford 7, Conn.

FORD INSTRUMENT COMPANY



PRECISION CAMS

- offered in a variety of types
- with tolerances to ±0.0005"
- for wide range of computing and motion applications

Whatever your computing or motion application, Ford Instrument can make the cam to meet your exacting needs...3-D Cams, grooved flat cams, external flat cams, grooved cylindrical cams. Our unique cam-producing facilities guarantee a "custom" job every time. Check us today.

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25

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Your Move

The men we seek are experts in their specialized fields, capable of filling responsible engineering positions with MELPAR, a leader in research and development. Perhaps one of these men may be you. We invite you to learn about our long-range military and industrial programs.

If you are experienced in one or more of the fields listed below, write us about yourself and let us tell you during a personal interview about our past record of success and how you can successfully fit into our future plans.

- *Data Handling Equipment (magnetic cores, magnetic recording equipment, digital computing techniques, analogue to digital conversion, shaft digitizers)*
- *Network Theory*
- *Flight Simulation (servomechanisms, pulse circuitry, electronic cabling)*
- *High-Frequency Antennas*
- *Audio and Video Circuit Design*
- *Small Mechanisms Design*
- *Mechanical Packaging of Electronic Components*

Technical Personnel Representative

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A Subsidiary of the Westinghouse Air Brake Co.

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or 11 Galen St., Watertown, Mass.

Lets see if "Commercial" PRESSED METAL STAMPINGS will reduce your cost...

Greater consumer appeal of this rotary lawn mower really paid off when the platform housing became a "Commercial" specialized steel stamping. Engineering improved the product because redesigning by "Commercial" made it lighter and more compact, thereby lengthening its life service and increasing its efficiency. Savings in cost were accomplished in so many ways, as usually is the case when a specialized stamping goes into a final assembly. Breakage is eliminated, there is a substantial reduction of the amount of metal used, several subsequent machining operations are not required, and the surface of the stamping is ready without finishing for painting.

You may well investigate the many opportunities for production economies and improvement of your product by seeing if the developed skills, working with modern tools and equipment, at "Commercial" can do it better with a specialized steel stamping. "Commercial" are stamping specialists who produce a lot of unusual stampings. We will be glad to assist in your design.

"COMMERCIAL"
PRODUCTS PREFERRED BY CUSTOMER ACCEPTANCE

THE COMMERCIAL SHEARING AND STAMPING COMPANY
Youngstown, Ohio Chicago, Illinois Salt Lake City, Utah

STAMPINGS · FORGINGS · TANK HEADS

PA-1

KEEP INFORMED

Burner Catalog

Reports that better results can now be obtained in firing rotary sand and stone dryers, and rotary calcining kilns, with the long narrow flame of the new series 480P Hauck burners for oil or gas are contained in catalog 414 available from Hauck Mfg. Co., 124–136 Tenth St., Brooklyn 15, N. Y.

Greater drying tonnage with less combustion chamber repairs, and good fuel economy have been proven in over 30 field trials and two years time of development.

High Pressure Bulletin

A four-page bulletin on solenoid valves for high pressure applications is offered by Atkomatic Valve Co. It illustrates features of Atkomatic bronze or stainless steel high pressure pilot operated and direct lift Solenoid Valves with diagrams of electrical circuits used for normally open and normally closed operations and is available from Atkomatic Valve Co., Dept. H-200, 545 Abbott St., Indianapolis 25, Ind.

Reduced-Oxide Iron Powder

Technical Data Sheets PMS 28A and 28B, issued by Plastic Metals Div., The National Radiator Co., Johnstown, Pa., give the chemical and physical characteristics of Plast-Iron B-212, a reduced-oxide iron powder designed specially for compacting parts requiring high tensile or transverse strength.

A table lists the properties of sintered specimens containing various percentages of copper, to show that sintering growth is narrowly restrained. Data are included also giving the strengths and other properties obtained with and without the use of copper.

Instrumentation Bulletin

A new system of instrumentation for the measurement and/or control of liquids developed by General Filter Co., Ames, Iowa, is described in a new eight-page bulletin, "Pneumatic Operated Control."

The bulletin illustrates the five basic principles used, its uses and applications in water and waste treatment plants, and the ease with which it can accomplish all the various types of process measurement and control. It is available from the company. Write for bulletin No. 5421.

Uni-Wash Dust Collector

Newcomb-Detroit Co., 5741 Russell St., Detroit 11, Mich., has issued a 24-page bulletin on Uni-Wash dust collectors used in foundries, industrial processing to transform dust into wet sludge. Both junior and senior models are described with engineering data, dimensions and application photographs.

Direct drive and V-belt units are described along with automatic sludge conveyor and automatic water level control features. Data on cooling effect, evaporation, and dust count, and a rule of thumb method for estimating air volume for dust control systems are included.

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Needle Control Valves

Design details and operating characteristics of its complete line of needle type valves are explained by the Foxboro Co., Foxboro, Mass., in a new eight-page bulletin, 5C-13. Engineered for applications requiring precise control of low rates of flow, the needle valve is described as an integral part of a complete control system, suitable for use over a wide range of operating conditions.

Reference material includes a table of nominal needle sizes with corresponding valve coefficients, and a characteristic curve showing the per cent of maximum flow in relation to the percent of total lift.

Utility Sheet Bulletin

Kaiser Aluminum and Chemical Corp. announces publication of new literature describing applications, specifications and availability of Kaiser Aluminum utility sheet. Special emphasis is placed on the use of the sheet for duct work. Advantages of greater heat delivery, smaller duct requirements, ease of fabrication and lower overall costs are cited.

Tables in the illustrated folder also show the weight per standard flattened sheet; weight per lineal foot of coil, and weight and coverage of equivalent galvanized gages. The folder may be obtained free from the Industrial Service Div., Kaiser Aluminum & Chemical Corp., 1924 Broadway, Oakland 12, Calif.

Heating Systems

Five major types of steam heating systems, with and without control, and a full line of valves, traps and steam power specialties are described in a new condensed catalog, Bulletin 110, published by Illinois Engineering Co., 2035 S. Racine Ave., Chicago, Ill.

The bulletin features Illinois' "Selectotherm" system, an automatically controlled high vacuum steam heating system that adjusts its heat output and fuel consumption to outdoor temperature and heat loss conditions. Also described are a steam heating system for installations that are zoned, that use steam for purposes other than heating, and that use steam supplied by central stations. This continuous flow control system, called Type A, is a two pipe system, governing the flow of steam to zones with pneumatic valves.

THE UNITED WAY

Lets see if "Commercial" METAL QUALITY FORGINGS will reduce your cost...

Metal quality of the nozzles releasing the tremendous thrust which assists in the launching of carrier jet aircraft is of life or death importance. The slightest hidden metal defect in the "as-rolled" steel would become apparent during the external and internal upsetting used in producing this forged nozzle.

The savings in cost of this metal quality forging produced by "Commercial" was more than enough to absorb shipping costs for a distance of nearly 1000 miles.

Should you have problems involving the use of formed metal parts requiring durability, efficient positioning of metal for required strength and finishing—let's see if "Commercial" forgings will not give you a lower cost by saving metal and eliminating rejects before any machining is done. And don't fail to recognize that forgings combine strength with toughness for greater wear resistance and shock load. "Commercial" are forging specialists who produce a lot of unusual forgings. We will be glad to assist in your design.

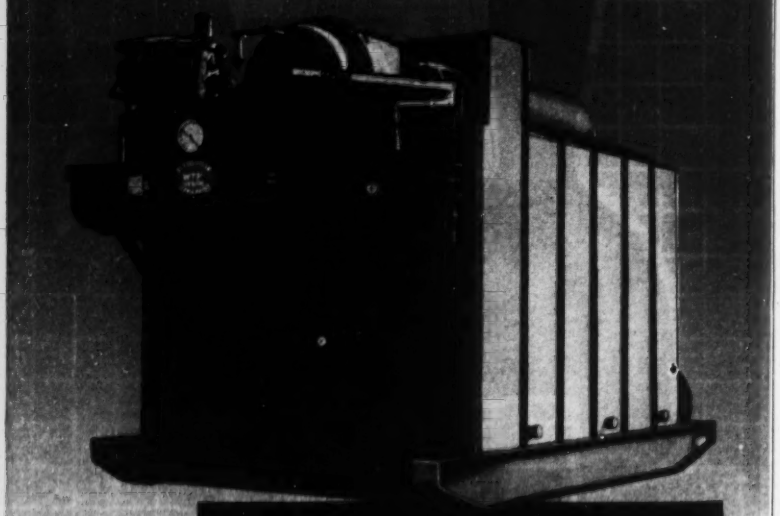
"COMMERCIAL"
PRODUCTS PREFERRED BY CUSTOMER ACCEPTANCE

THE COMMERCIAL SHEARING AND STAMPING COMPANY
Youngstown, Ohio Chicago, Illinois • Salt Lake City, Utah

STAMPINGS • FORGINGS • TANK HEADS

PA-1

Here's MORE POWER for your purpose—



MORE for every boiler investment dollar!

TITUSVILLE

for instance . . .

- Greater Efficiency
- Simplicity of Operation
- Compact Package Design
- Wide Modulating Range
- Rapid Response to Load Changes
- High Quality Steam at All Times

TYPE WTP
WATER TUBE
STEAM GENERATOR

Matching high power output with maximum efficiency and genuine package design, the Type WTP is entirely shop-assembled and shipped complete with all components—ready to produce as soon as connected to services. Ten sizes, from 7500 to 30,000 lbs steam capacity per hour. All oil and gas fuels, and combination oil and gas.

WRITE FOR current Bulletin B-3275

TITUSVILLE IRON WORKS CO. TITUSVILLE, PA.

Struthers Wells

A division of

THE TITUSVILLE IRON WORKS COMPANY

TITUSVILLE, PENNSYLVANIA

Manufacturers of A COMPLETE LINE OF BOILERS FOR EVERY HEATING AND POWER REQUIREMENT

KEEP INFORMED — NEW EQUIPMENT · BUSINESS NOTES · LATEST CATALOGS

Hardening and Drawing Furnaces

Surface Combustion Corp., Toledo 1, Ohio, has released a new bulletin, SC-164, on its complete line of furnaces for hardening and drawing or tempering operations. Included in this illustrated, two-color bulletin are direct-fired and controlled atmosphere furnaces of both the batch and continuous types. Completely automatic harden and draw lines are of special interest. A table provides data on the hardness achieved at specific drawing temperatures for the most common steels.

Stress Rupture Values

A new data card published by the Tubular Products Div. of The Babcock & Wilcox Co. presents stress rupture data on 11 tubing steels used in high temperature service. Included among these steels are carbon steel, intermediate chrome-molybdenum steels and stainless steels.

Data developed by stress rupture tests offer an important means of evaluating the characteristics of metal for operation under stress and high temperatures over long periods of time. Copies of data card, known as TDC 153-A, are available free upon request to the company's offices at Beaver Falls, Pa.

Lattice Braid Packing

A new folder, A-131, describing a patented lattice braid rod and shaft packings is now available from the Garlock Packing Co., Palmyra, N.Y.

The folder points out construction features and describes available materials, sizes, and forms. It also contains illustrative service reports from users in various industries.

Indicator-Recorder

The Omega Machine Co. loss-in-weight indicator-recorder for use with the volumetric dry feeders is illustrated and described in Bulletin 50-L13 issued by Omega Machine Co., Division of B-I-F Industries, Inc., 345 Harris Ave., Providence, R. I. The Bulletin, 50-L13, includes a description of the use and operation of the recorder.

Dall Flow Tube

Builders-Providence, Inc., 345 Harris Ave., Providence, R. I., has issued a 16-page engineering bulletin on the new Dall flow tube. The bulletin, 115-L3, describes the new short differential producing metering device which has the lowest permanent loss of head of any known velocity-increasing differential producer.

Included is information on recovery characteristics, accuracy, applications, range, flow formula, laying length, and working pressure of the device, and sections on installation, power consumption, effect of approach and downstream piping and fittings, and location of instruments. Tables and graphs are included in the bulletin to aid in the selection of the proper Dall flow tube and its accompanying secondary instruments.

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Globe, Angle Valves

Kennedy Valve Mfg. Co., 1021 E. Water St., Elmira, N. Y., has printed a new bulletin, No. 110, describing its new "500 Brinell" line of bronze globe and angle valves.

Features of the line include seats and disks of cutlery grade, true "500 Brinell" stainless steel, precision machined on specially designed equipment. Both seats and disks are polished to a 10 micro-inch smoothness for perfect, leak-proof seal. Kennedy guarantees these seats and disks to be "bottle-tight" after abuse by pipe chips, pipe scale silicates or carbonates.

A pistol-grip handwheel on all valves gives a firm, easy 3-way grip on top, sides and bottom, with full palm protection because the wheel nut is down inside the deep pocket. Finger-wide spacing for ribs, combined with indented rim notches under the rim, eliminates slip even with greasy gloves.

Machinability of Free-Cutting Brass

Machinability of free-cutting brass is compared with that of leaded steel in a 48-page booklet published by Titan Metal Mfg. Co., Bellefonte, Pa. The booklet reports results of laboratory tests on the two commercial metals, as well as results of six-month production runs manufacturing booster bodies out of brass and leaded steel.

Comparison of leaded steel and free-cutting brass pieces produced in a 704-hr continuous production operation on Conomatic machines is a feature of the booklet. Also compared is wear on the cutting tools when producing leaded steel as against brass booster bodies. The publication is titled "First Report: The Machining Characteristics of Leaded Steel and Free-Cutting Brass."

The booklet is complete with tool photographs and charts and diagrams depicting brass and leaded steel machinability as measured by wear on the cutting and drilling tools. Scientific data on the conditions of laboratory and production tests are supplied.

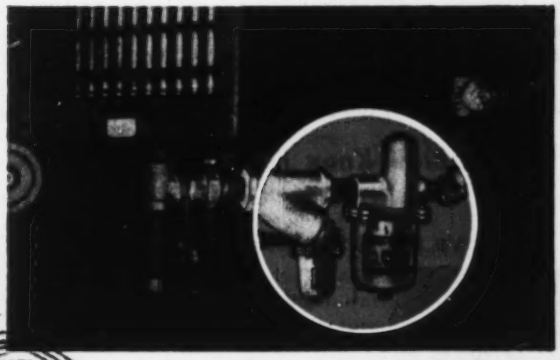
Single copies of the 48-page booklet are available free by writing to Dept. T-75, Titan Metal Mfg. Co., Bellefonte, Pa.

Filming Amines

"Film Forming Corrosion Inhibitors Also Aid Heat Transfer" is the subject of technical paper No. 129, prepared by W. H. & L. D. Betz. The paper contains many references to the protection afforded by filming amines and the attendant reduction in maintenance costs secured through protection against corrosion.

Filming amines function by forming a nonwettable film over the metal surfaces contacted. According to the company, the film acts as a barrier between the metal and condensate, and since the metal does not become wetted, corrosion is prevented even in the presence of condensate containing large amounts of carbon dioxide and oxygen. Copies may be obtained from W. H. & L. D. Betz, Gillingham & Worth Sts, Philadelphia 24, Pa.

● You'll be just as comfortable in your factory, warehouse, or office building this winter as you would be in Florida, if you will follow this simple suggestion. Put fast-venting Heat-Kwik Super-Silvertop Steam Traps on every unit heater. Super-Silvertop Heat-Kwiks bring unit heaters up to maximum heat output in 2½ minutes—save hundreds of dollars by letting you turn on steam as much as a half hour later every morning. Man-sized Super-Silvertop *inverted bucket* traps succeed when thermostatic or orifice type traps fail because they alone discharge high temperature condensate, and operate at low pressure differentials. Use them on unit heaters to keep your plant warm, reduce unit heater corrosion, and to save on fuel bills. See your jobber today!



SUPER-SILVERTOP STEAM TRAPS

FREE!

This 36-page book shows how to select the proper sized trap for unit heaters and other steam applications.

THE V. D. ANDERSON COMPANY
Subsidiary Chesapeake Industries
1930 West 96th Street • Cleveland 2, Ohio

Gentlemen: Please send me the following:
36-page book "Solving Steam Trap Problems"

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Company _____

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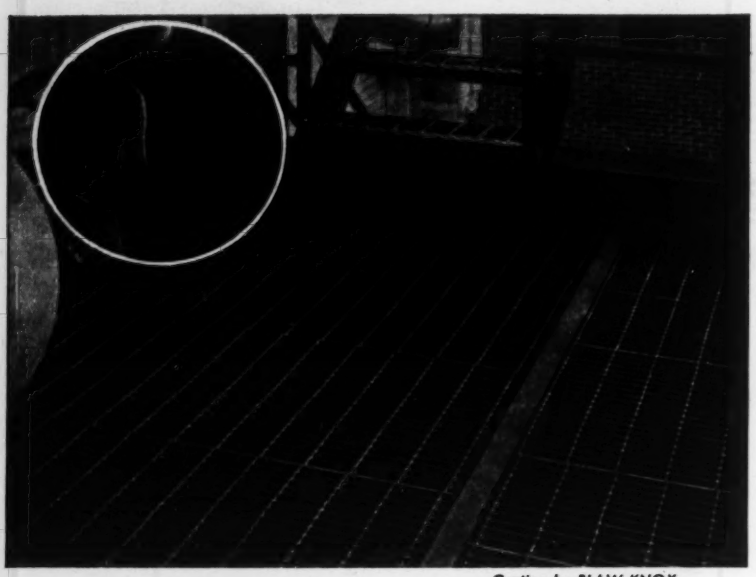


Grating by BLAW-KNOX

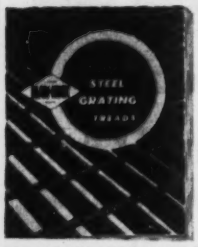
where can you use steel grating?

You undoubtedly use a lot of steel grating in your plant—floors, platforms, walkways, catwalks and stair treads, for example.

But how about grating for fan guards and shelving—for covering open pits and light wells? And how about other uses throughout your plant that no one has thought of—as steel grating is adaptable to many uses.

If you have any problem about a common application or an unusual application or a possible application, we'll be glad to hear from you. And to give you a prompt answer.

Only Blaw-Knox Electroforged® Steel Grating and Stair Treads —have these five exclusive features:



1. **rigid one-piece construction—easy to install**
2. **all surfaces accessible—easy to paint**
3. **no sharp corners to clog—self-cleaning**
4. **maximum open area—for light and ventilation**
5. **non-slip twisted crossbar—safe footing**

A short note will bring you a copy of new Bulletin No. 2365-R —a dimensional sketch will bring you a quotation.

BLAW-KNOX

BLAW-KNOX COMPANY
2105 Farmers Bank Building • Pittsburgh 22, Pennsylvania

BLAW-KNOX EQUIPMENT DIVISION
GRATING DEPARTMENT

GRATING APPLICATIONS: floors • platforms • walkways • catwalks • stair treads • fan guards • shelving • and many other uses, both outdoors and indoors, for versatile steel grating.

KEEP INFORMED — NEW EQUIPMENT · BUSINESS NOTES · LATEST CATALOGS

Pipe Wrap Data Book

Owens-Corning Fiberglas Corp., Toledo 1, Ohio, has announced the availability of a four-page data book describing Fiberglas low pressure pipe insulation. The illustrated booklet describes uses of the insulation on cold and hot water and low pressure steam lines, and provides information on the jackets which are provided for each specific application.

Various advantages of Fiberglas low pressure pipe insulation are described, as is a graphic detailing of thermal performance under various temperatures. Application details of the pipe insulation are illustrated in a step-by-step manner with precise text describing the complete operation.

Bearing Catalog

Microtech Corp., 200 W. Colorado St., Pasadena 1, Calif., has announced as available a 24-page engineering catalog, No. 541, on super-precision ground, instrument, and miniature bearings.

The catalog lists technical information on different types of bearings, shaft and housing fits, tolerances, calibration of bores and outside diameters, internal clearances, lubrication, packaging and handling. Descriptions and dimensions of the bearings are included.

Industrial Rubber Catalog

Raybestos-Manhattan, Inc., Manhattan Rubber Div., Passaic, N. J., announces the publication of a new edition of its catalog of rubber products for industry. The catalog covers V-belts, transmission belts, conveyor belts, all types of hose, molded products and describes the Poly-V Drive which combines the simplicity of flat belts and grip of V-belts.

Electrical Resolver

A two-page bulletin illustrates and describes a new size 15 Telesyn resolver, the latest and smallest addition to Ford Instrument's line. The 5-ounce resolver continuously performs trigonometric operations involving resolution of input voltages in sine and cosine components, according to the company.

Full data on the different models available, specifications, dimensions and information on operation and construction are provided in the bulletin, which is available from Ford Instrument Co., Div. of Sperry Corp., 31-10 Thomson Ave., Long Island City 1, N.Y.

2-Pole Motor Bulletin

Design of Allis-Chalmers two-pole motors 900 hp and larger is described in a new eight-page bulletin released by the company. The bulletin incorporates a reprint of the article, "Auxiliary Drive Motor Keeps Pace With Modern Power," and includes diagrams with a sectioned view of a typical large two-pole squirrel-cage induction motor. Another diagram shows how the machine is spirally ventilated. Copies of the bulletin, are available on request from Allis-Chalmers Mfg. Co., 949 S. 70th St., Milwaukee, Wis.

Titanium Alloys

A new booklet, prepared by Mallory-Sharon Titanium Corp., Niles, Ohio, gives complete physical properties and forging recommendations for the MST 3A1-5Cr alloy. This is a titanium alloy containing 3 per cent aluminum, 5 per cent chromium and less than 0.1 per cent carbon, and was developed primarily for bar and forging applications.

The alloy is produced by the unique double-melting process, which was developed by Mallory-Sharon, which is said to result in complete alloy homogeneity and consistent quality, giving excellent forging and good machining characteristics. In addition, alloying ingredients can be controlled with great precision, and the content of carbon and other impurities can be held as low as the amount inherent in the sponge raw material.

Hydraulic Grinder Catalog

Rivett Lathe and Grinder, Inc., has issued a 16-page catalog describing its model 1024 internal and universal hydraulic grinder. The machine has a double-end wheelhead, which swings 180 deg for internal and external grinding. Copies of the catalog, 1024B, can be obtained from Rivett Lathe Grinder, Inc., Brighton 35, Boston, Mass.

Valve Bulletin

The Golden-Anderson cushioned Flowtrol valve is described in a new technical bulletin recently published by Golden-Anderson Valve Specialty Co., 1223 Ridge Ave., Pittsburgh 33, Pa. The valve was designed to replace globe, angle, plug or gate valves that require frequent manual opening and closing at considerable waste of time and effort. Copies of the bulletin, W8-A, can be obtained by writing to the company.

Unit Heaters

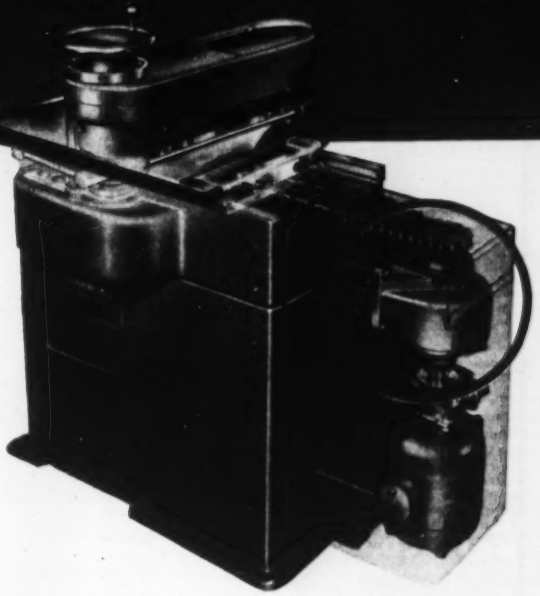
Bulletin 7517, covering the latest design of Venturafin unit heaters for steam or hot water applications, is available from American Blower Corp., Tireman Ave. at Roselawn, Detroit 32, Mich. The 48-page booklet covers features of design, general engineering data, capacity tables, and piping diagrams.

Also included is information on diffusers, external ductwork, mounting heights, pipe sizes, quietness ratings, wiring diagrams, selection examples and typical specifications.

Teflon Tapered Plug

Bulletin No. 754, describing Republic "Lo-Temp" valves, is available from Republic Mfg. Co., 1930 W. 77th St., Cleveland 2, Ohio. The valves use Teflon tapered plugs which are said to eliminate the need for a lubricant to prevent seizing, even at temperatures as low as −65 F and as high as 250 F, and at pressures to 100 psi. The company claims the Teflon plug is not affected by acids, alkalis or gases. "Lo-Temp" with aluminum alloy body is suitable for aircraft use, and stainless steel for use in chemical food and dairy industries.

Shaving newspaper plates
. . . quickly, accurately



Hammond Plate Shavers use

WINSMITH SPEED REDUCERS

Shaving 19″ x 26″ newspaper plates to correct printing height within 12 seconds . . . shaving 30 to 40 thumb nail shell plates at one time with uniform accuracy, this Hammond Model S-8 Plate Shaver is equipped to help a newspaper go to press before deadline.

Directly coupled to a 1½ HP motor in the drive mechanism, which moves the plates into the carbide blade, is a Winsmith Model 11H Differential Speed Reducer with a reduction ratio of 108:1. Correct speed for fast, smooth and accurate shaving is assured.

Compactness, ruggedness and dependability have made Winsmith reducers most preferred for applications within the 1/100 to 85 HP range, in ratios of 1.1:1 to 50,000:1. Why not find out how this complete line of differential, worm gear, helical gear and worm-helical reducers can meet your needs to best advantage?

For details, request Catalog 148 . . . and for information on Winsmith's new "C" Line Worm Gear Speed Reducers, request Bulletin HW654.

WINSMITH, INC.
333 June Street
SPRINGVILLE (Erie County), N. Y.

WINSMITH SPEED REDUCERS

MEMBER OF AGMA

Dollars fly away when your CHIMNEY is not efficient!

Have fuel costs mounted beyond reason? Do you have all the power you need at all times?

When new boilers have been added or power conditions increased it frequently happens that the load on the chimney is built up to a point where the chimney no longer permits efficient operation . . . fuel costs mount, power lags, and the whole plant suffers.

It is time to check on your chimney. A Consolidated engineer will inspect your chimney at no inconvenience to you and make specific recommendations, if necessary, to lower your costs and increase operating efficiency.

This service places you under no obligation. Make use of it today.

Design—Construction
Linings—Water Proofing
Repairs
Aircraft Warnings
Lightning Rods
Demolition

Write for literature on building and repair service.

100 ft. x 4 ft. 6 in. Octagonal Face Brick Chimney, designed and built for St. Charles Hospital, East Toledo, Ohio.

CONSOLIDATED CHIMNEY CO.
Engineers and Builders
6 South Dearborn St., Chicago 3, Ill.

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NEW EQUIPMENT | BUSINESS NOTES | LATEST CATALOGS

Catalog on New Nuts

A 12-page catalog describing its new line of 12 point plain and self-locking nuts is available from National Machine Products Co., Utica Rd., Utica, Mich. The catalog describes the 12 point nut as having a stronger wall and greater bearing area than equivalent hexagon nuts.

The new nuts are designed to permit smaller tool clearance than is practical with hexagon nuts. The company claims they are furnished at the same price as equivalent hexagon nuts.

Zirconium Booklet

Carborundum Metals Co., Inc., Akron, N.Y., organized for the dual purpose of supplying AEC and industry with zirconium metal suitable for their specific applications, has published a booklet, "Facts About Zirconium," for general distribution. The booklet is a concise compilation of information about the history and production of zirconium. The mechanical and physical properties, chemical properties, facts about fabrication of zirconium such as melting, forging, rolling, welding, machinability are discussed. One chapter treats of zirconium chemicals such as zirconium tetrachloride, dioxide, sulphate and Carbo-Cast-Aid. The appendix lists data on crystallographic features, atomic and nuclear properties.

Cementable Teflon

The United States Gasket Co., Camden 1, N. J., is offering a bulletin on cementable Teflon sheets. Unlike normal Teflon, which is antihesive, this product may be cemented with standard commercial adhesives to metal, wood, glass, rubber, leather, ceramics, or other material.

Cementable Teflon is pure Teflon with a specially prepared surface which is a homogeneous part of the sheet.

The bulletin, Catalog MI-443, gives data on chemical, electrical, and physical properties; typical uses; suggestions on application and bonding agent selection; and dimensions and weights of standard size sheets.

Weldments and Castings

Acme Tank & Welding Division of United Tool & Die Co., West Hartford 10, Conn., has available a booklet entitled "The Facts about Weldments and Castings." The booklet lists the relative strength, comparative properties, safety factors and costs of steel and cast iron.

Gas Analysis

Ellison Draft Gage Co., Inc., 548 W. Monroe St., Chicago 6, Ill., has published a 12-page treatise on gas analysis which also details the construction and operation of Orsat type gas analyzers. The booklet contains a number of helpful charts and formulas. To cover the cost of printing and mailing, a token charge of 50¢ per copy is being made by the company.

Water Treatment

The importance of eliminating high product rejection and damage to machinery from impure water is outlined in a new six-page folder just issued by Hall Laboratories, Inc., Hagan Bldg., Pittsburgh 30, Pa. Water may contain many kinds of potential trouble makers which can operate in boilers, condensate return lines, condensers, heat exchangers, and process equipment, according to the folder "Primary Water Treatment."

Claiming that such troubles arise from water which has corrosive effects, the folder mentions methods of primary treatment which means doing something to a water to make it more suitable for its intended application before it reaches the point of application.

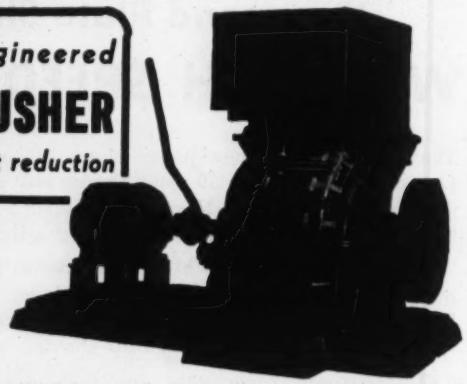
Bushings Bulletin

Technical Bulletin A-628A, on Taper-Lock bushings, hubs and adapters, has been announced as available from Dodge Mfg. Corp., Mishawaka, Ind. Information throughout the bulletin is mostly in tabular form. Data relating to all sizes of Taper-Lock bushings are included as well as cross section drawings, bushing numbers, bore sizes, dimensions, weights, keyseats and list prices.

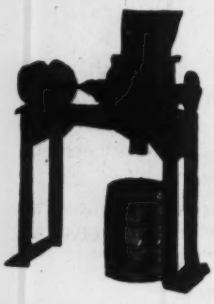
The bulletin also contains similar data on Taper-Lock weld-on hubs and adapters for Taper-Lock bushings.

There's a job-engineered
AMERICAN CRUSHER
for uniform . . . low-cost reduction

. . of COAL, CLAYS, CHEMICALS, STONE, METAL TURNINGS, WOOD, DRY ICE, FOOD hundreds of products of every description.



Metal Turnings Crusher—reduces long, curly turnings of steel, alloys, brass, aluminum, etc., to uniform chips for highest cutting oil recovery . . . increased scrap value.



Laboratory Mill—for testing pilot plant operation and waste reduction.

"AC" *Ring Mill*—with exclusive shredder rings—for uniform, high tonnage reduction. 500 TPH. "24 Series" ring or hammer crushers offer capacities to 50 TPH.....“30 Series" Hammermills to 100 TPH.

Write for complete information on the famous American line of crushers.

American PULVERIZER COMPANY
Originators and Manufacturers of Ring Crushers and Pulverizers
1541 MACKLIND AVE.
ST. LOUIS 10, MO.

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Drafting Equipment

Hamilton Mfg. Co., Two Rivers, Wis., announces catalog No. 14 on drafting room equipment. The 34-page booklet illustrates and describes auto-shift tables, drawing boards, dust covers, filing equipment in steel and wood, tables, parallel rule attachments, steelwood tables, drafting tables and tracing tables.

Also listed are specification tables to aid in the selection of the proper equipment and a suggested floor plan designed to save space in drafting rooms.

Precision Test Instruments

A four-page, two-color brochure describes briefly a family of high-precision test instruments, including recording oscillographs, galvanometers, instrument amplifiers and bridge balances, analog computers, function generators and related instruments. Instruments are used primarily for multichannel recording of both static and dynamic test data in engineering, research and development. It is available from Wm. Miller Instruments, Inc., 325 N. Halstead Ave., Pasadena 8, Calif.

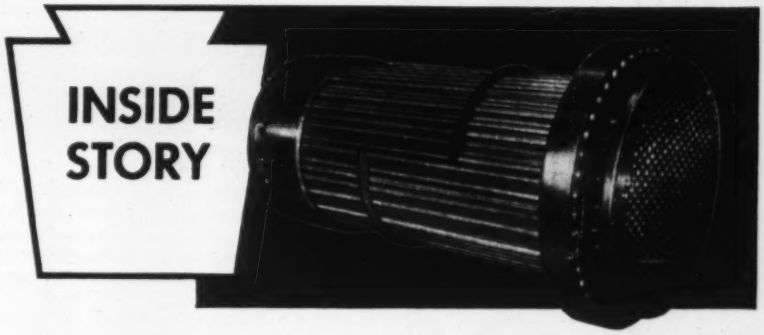
Plug Valve Actuators

An eight-page bulletin on plug valve actuators has been released by Ledeen Mfg. Co. The bulletin describes tandem type actuators for valves requiring relatively high torques to operate, and the new floating bar type actuators for use on valves requiring lower operating torques. It also shows actuator selection table, typical applications, dimensions and weights, and various mountings. Copies of Bulletion 3020 may be obtained from Ledeen Mfg. Co., 1600 S. San Pedro St., Los Angeles 15, Calif.

Tubular Forming Booklet

A booklet that gives examples of how certain tubular products are formed by the Mullins' Koldflo method has been published by Mullins Mfg. Corp., Salem, Ohio. Pointing out the design possibilities of this process of moving steel in its cold state, the booklet provides step by step illustrations of the forming of an intricate balancing cup and an accumulator shell 23 in. long. Other information of value to design and process engineers is included.

Additional Opportunities are offered in the display advertisements— on pages 44, 50, 51, 64, 67, 76, 108, 130



Designed *right*...built *right*...that's why Downingtown heat transfer equipment works extra well in the process line.

Designed by experienced engineers ...expert at solving specific heat exchanger problems.

Built by craftsmen skilled at holding extra-tight tolerances on tube fit in tube hole...tube fit in baffle hole... alignment of baffles...and bundle fit in shell—details which help assure efficient performance.

Fabricated from various grades of Carbon Steel, Stainless Steel, Stainless and Nickel Alloy Clad Steel, Nickel, Nickel Alloy, Aluminum, Copper Alloy, Ampco 8, Karbate, Haveg or other material. Built to ASME code where necessary.

Send for additional information on heat exchanger design.

Downingtown Iron Works, Inc.

HEAT EXCHANGERS—TOWERS—PRESSURE VESSELS
STORAGE TANKS—STEEL AND ALLOY PLATE FABRICATION

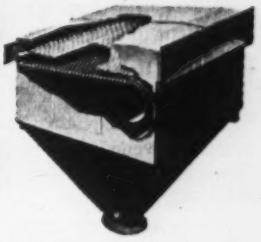
Downingtown, Pennsylvania
New York Office: 52 Vanderbilt Avenue, New York 17, N. Y.

DIVISION OF: Pressed Steel Tank Company
Manufacturer of Hackney Products
Milwaukee 14, Wisconsin

CONTAINERS AND PRESSURE VESSELS FOR GASES, LIQUIDS AND SOLIDS

For Larger-Boiler Fly Ash Collection and Valuable Dust Recovery

Buell-designed 'LR' Collector Stops Fly Ash From Small Boilers!



BUELL 'SP' ELECTRIC PRECIPITATOR

BUELL MECHANICAL CYCLONE SYSTEM

High efficiency from 100 to 2000 BHP. Traps 99% of all 100-mesh and larger cinder discharge. Is effective on natural draft boilers!

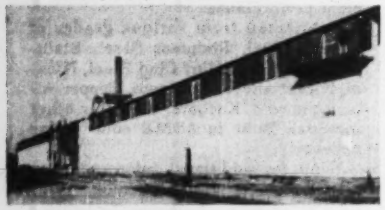
For complete details write for latest 'LR' Bulletin. Buell Engineering Company, Dept. I-43, 70 Pine Street, New York 5, New York.

buell

Engineered Efficiency in
FLY ASH COLLECTION

Stop This with RESOLITE

Shatterproof translucent panels save high labor cost of pane replacement . . . need no maintenance.



- **Rugged**—Shatterproof, strong as metal, fiberglass-reinforced Resolite has *unlimited* life without protective treatment or maintenance. There are no broken panes to replace.
- **Low cost**—Skylights and sidewall lights are installed at *half* the cost of regular glazing material. Resolite nests with and is fastened like any corrugated metal or asbestos sheet. It requires no special framing or flashing . . . is installed with ordinary tools by workmen with no special training. Where sash is specified, flat sheets, factory-cut to size, are installed like glass.
- **Better light**—Resolite daylighted buildings are filled with bright, evenly distributed daylight . . . diffused light that prevents glare, reduces eyestrain. Packaged Resolite vented units designed for easy installation with Resolite or other corrugated material are available in many sizes.
- **Other uses**—Resolite is also ideal for partitions and decorative facings of all types. Anywhere a combination of light, strength and beauty is desired Resolite is the answer. A complete line of accessories for easy, trouble-free installations is available.

For further information see Sweet's Plant Engineering, Architectural or Industrial Construction Files or Write:

RESOLITE Corporation

Box 502, Zelienople, Pa.

Distributors in principal cities, U.S. and Canada

KEEP INFORMED — NEW EQUIPMENT, BUSINESS NOTES, LATEST CATALOGS

Drive Output Units

Oilgearducers, packaged hydraulic drive output units consisting of Oilgear's constant displacement axial piston motors integral with Falk's line of concentric and right angle all-steel reducers are described in a new eight-page bulletin 56610 issued by Oilgear Co., 1555 C., W. Pierce St., Milwaukee 4, Wis. Five sizes of hydraulic motors for drives up to 20 hp are described. Reducers with wide ratio combinations provide maximum output speeds from 1.7 to 1170 rpm. Normal output torques range from 42 lb-in. to 41500 lb-in. with 1100 psi pressure. Starting and peak torques are 60 per cent higher. Specifications cover complete variable speed drives with and without Oilgearducers. Typical applications are described, and installation dimensions are included.

Tips Steel Valve Users

A "Technical Tips" booklet describing and illustrating data gathered by the Edward laboratories on valve material, installation and usage has been published by Edward Valves, Inc., subsidiary of Rockwell Mfg., 1201 W. 145th St., East Chicago, Ind.

Subjects discussed include "What Heat Does to Valve Trim Hardness," "What Thermal Expansion Does to Valve Materials," "Use of Globe Valves for Throttling Service," "High Temperature Lubricants for Valve Studs and Bushings," and "'Creep' Robs Metal Strength at High Temperatures."

Water Treatment for Cooling Towers

Water treatment for cooling towers is the subject of an informational bulletin released by Allis-Chalmers Mfg. Co.

The bulletin discusses types of cooling systems together with such problems as corrosion of metal surfaces, inorganic scaling, organic growths such as algae and bacterial slime, and delignification of the wood in the tower.

Information on the selection of chemical treatment is included along with a table showing the type and amount of treatment found to be effective for prevention of scale or corrosion under various operating conditions. Copies of the bulletin, 28X7501A, are available on request from Allis-Chalmers Mfg. Co., 949 S. 70th St., Milwaukee, Wis.

Space Heater Studies

A brochure of engineering case studies, recently released by Dravo Corp., 1203 Dravo Bldg., Pittsburgh 22, Pa., describes nine ways in which warm air space heaters were used to heat a variety of diversified manufacturing plants. Each bulletin in the brochure describes an individual plant's requirements and lists the benefits derived by installing oil- or gas-fired warm air space heaters.

Industries featured are paint and glass work, clothing, wiping cloth processing, radio assembly, starch laboratory, plywood manufacturing, granite polishing and inscribing, mining tool construction and pulp wood log debarking.

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WELDED DESIGNS ELIMINATE COSTLY OPERATIONS

AT Dahlstrom Machine Works, Inc., standard and special machines are manufactured from welded steel using structural shapes and plate. In addition to more efficient, lower cost production, direct benefits include lighter product weight, greater strength and easier adaptation to meet special customer needs.

The motor swing base (Fig. 1) as an example is made from steel plate and simple tubing. The components are tacked and then fillet welded with Manual Lincolnweld hidden-arc welding. Considerable finishing time is saved since welds are self-cleaning and the steel plate requires no filling before painting as when castings are used.

With Manual Lincolnweld, the cost of welding is reduced one-third over conventional welding with coated electrodes. Welds have high penetration and high ductility assuring top strength and dependability in service.

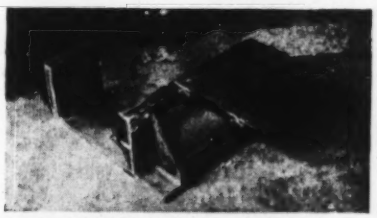

Fig. 1 Motor Swing Base is built up from components of tubing and steel plate. Photos Courtesy Dahlstrom Machine Works, Inc., Chicago, Ill.

Fig. 2 Simpler Production Fillet welding of bracket for low cost manufacture. Manual Lincolnwelding in agglomerated flux eliminates arc rays and smoke.

HOW TO DESIGN FOR LOW COST

Latest design principles for converting products to steel are presented in Lincoln WELDesign Manual, available at nominal cost for home study. Also available are free bulletins on use of welded steel for efficient product designs. Write . . .

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Quick-Seal Hose Coupling

A quick connect-disconnect hose coupling for water, oil, steam, gas and chemical lines, which provides permanent freedom from leakage, is described in a bulletin published by Titeflex, Inc., Hendee St., Springfield 4, Mass.

The 16-page booklet describes the simple construction of the coupling and points out how it provides sealing and swiveling action. Also described in the bulletin are single- and double-check valve modifications of this coupling.

A list of users indicating the industries in which the coupling has been applied, a table of pressures at which it can be used, tables of the materials and sizes in which the coupling is manufactured, and instructions for ordering are also included in the bulletin.

Industrial Ovens

A new 16-page bulletin on industrial ovens has been issued by Newcomb-Detroit Co., 5741 Russell St., Detroit 11, Mich. Engineering, manufacturing and installation for all processing ovens is described. The bulletin covers oven types, application to industry, source of heat, selection of heaters, control of heat, distribution of heat. Typical oven installations and a complete modern finishing process are pictured and described.

Nylon Bearings

A new eight-page illustrated catalog has been published to describe the standard lines of Nylined bearings and Nyliners manufactured by Thomson Industries, Inc., Manhasset, N. Y. The advantages of Nylon as a bearing material, particularly where bearings must operate without oil lubrication, are explained.

In addition, the catalog contains engineering data, installation information, and a bearing evaluation chart. The literature also describes a number of special type Nylined bearings which are available on special order.

Aluminum Duct Systems

Kaiser Aluminum & Chemical Sales, Inc., 1924 Broadway, Oakland 12, Calif., announces the publication of a new 32-page booklet entitled "The Design of Aluminum Duct Systems" said to give engineers and contractors practical and authoritative data on friction losses in air conditioning duct systems.

The booklet reports experimental tests which demonstrated the greater smoothness of aluminum compared to galvanized iron dropped friction losses as much as 20 per cent below galvanized ducts. Two friction loss charts based on exact, experimentally-determined aluminum roughness characteristics and identical in form to those published for galvanized iron in the "ASH & VE Guide" are included in the booklet. The concluding section presents detailed step-by-step design procedures and recommendations for sizing round or rectangular ducts for heating, ventilating, or air conditioning systems.

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NEW EQUIPMENT | BUSINESS NOTES | LATEST CATALOGS

Electrodes, Electrode Assemblies

A new catalog, EN-S5, describing "pH Electrodes and Electrodes for Measuring Redox Potentials—Assemblies, Parts and Accessories," has been published by Leeds & Northrup Co., covering its complete electrode line, chemicals for electrode servicing, and auxiliary electrode equipment such as clamps, holders, thermometers.

The catalog is designed to present electrode assemblies for measurement, recording, and/or control of solution pH and redox potentials. It is available from Leeds & Northrup Co., Advertising Div., 4907 Stenton Ave., Philadelphia 44, Pa.

Double Crank Presses

Information covering the complete new line of Niagara straight side double crank presses has been published in Bulletin 64-H by Niagara Machine & Tool Works.

Illustrated and described are Niagara's fully enclosed design, one-piece and four-piece frame construction, box-type slides, low inertia clutch, clutch control, lubrication and optional accessories. Well defined specifications for the entire 50 through 300-ton press line have been tabulated for quick reference. A copy of the bulletin can be obtained by writing to the company at 683 Northland Ave., Buffalo 11, N. Y.

Printed Circuits

A four-color 12-page booklet on the use of Formica copper clad for printed circuits in instruments and electronic equipment has been published by the Formica Co., 4615 Spring Grove Ave., Cincinnati 25, Ohio.

The booklet describes printed circuits and outlines suggestions for selecting the base laminate. It outlines procedures which have been used successfully by manufacturers of printed circuits by photo-engraving, offset or silkscreen printing methods. Various applications of these processes are described.

Permanent Piping

Industrial plants are among the examples used to illustrate "Piping for Permanence," a new 32-page bulletin published by the A. M. Byers Co., Pittsburgh, Pa. Contained in the bulletin is technical data based on an analysis of thousands of piping systems in which wrought iron is specified to help solve corrosion problems. Sections of the new publication are devoted to a round-up of wrought iron pipe installations, a review of piping properties essential to long and economical service life, descriptions of individual service in building-piping systems and recommendations to help reduce the rate and severity of corrosion.

Hardness Tester Catalog

A comprehensive, illustrated catalog giving engineering data, uses, design features of the complete line of Rockwell hardness testers has been prepared by the Wilson Mechanical Instrument Div., American Chain & Cable Co., 929 Connecticut Ave., Bridgeport 2, Conn.

The catalog details the scope of Rockwell applications in industry and includes data on the normal hardness tester, superficial tester, accessory and special tester, and micro and macro hardness testers. The unit retains the simplicity of hardness designation by a letter and number on a direct reading machine and is described as a practical tester for accurately measuring the hardness of all types of metals and alloys.

Safety, Relief Valves

A new catalog providing selection and capacity data for complete specification of air, gas, steam and liquid safety and relief valves as components of products involving pneumatics or hydraulics, is available on request from Kunkle Valve Co., 121 S. Clinton St., Fort Wayne 2, Ind.

The 48-page catalog includes specifications for a wide range of types and sizes in bronze, iron, steel and alloys.

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Shows typical installations of ROCKFORD CLUTCHES and POWER TAKE-OFFS. Contains diagrams of unique applications. Furnishes capacity tables, dimensions and complete specifications.

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Chain Drive Catalog

A revised 16-page illustrated catalog, C72-51, including new and expanded data on capacity ratings of Morse Hy-Vo high speed, heavy-duty chain drives is now available from Morse Chain Co., 7601 Central Ave., Detroit 10, Mich.

Operating principles and test data are included for drives that will carry up to 190-hp per in. of chain width at continuous chain speeds up to 6000 fpm. Specifications and capacity curves are included for standard $^{3}/_{4}$, 1, $1^{1}/_{4}$, $1^{1}/_{2}$ and 2-in. pitch chain from 2 to 12-in. wide. Installation and lubrication recommendations are also included in the catalog.

Vibrating Equipment

A 230-page catalog on Jeffrey-Traylor vibrating equipment has been published by the Jeffrey Mfg. Co., Columbus 16, Ohio. The catalog, No. 870, illustrates and details information on feeders, conveyors, coolers, dryers, mixers, constant weight feeders, bin check valves, packers, screens, controls and magnetic separators.

Heavy Duty Alloy

A new leaflet on "Jalloy, Grade 3," a special alloy steel for heavy duty use, is available from Jones & Laughlin Steel Corp., Pittsburgh 30, Pa. Outlined in the leaflet are properties, composition, applications, case histories, and information on heat treatment of this steel for optimum results.

Liquid Filter Folder

A four-page illustrated folder, describing Wagner Brothers' line of permanent membrane type liquid filters, is now available upon request to the manufacturer, 400 Midland Ave., Detroit 3, Mich. The literature explains precoating, filtering and cleaning operations, with schematic drawings showing flow directions during each of these phases.

The folder tells how efficient, low cost clarification of solutions is made by filtering acid, alkaline or neutral liquids through a series of permanent membranes—wire well screen, porous stone or porous carbon—caked with diatomaceous earth, to remove all suspended particles down to $^{1}/_{10}$ micron.

Mechanical Drive Turbines

General Electric's type DP mechanical-drive turbines rated from 10 to 1200 hp and 1000 to 6500 rpm are described in a revised bulletin designated GEA-4955B. Special design features as well as applications for pumps, compressors, fans, blowers, and similar equipment are covered in the publication.

Cutaways, schematic drawings, and photos of DP features are included. Details of the lubrication system, a table of dimensions, modifications of the basic standard design for special requirements, procedure for calculating approximate steam rates, and governing system are among the major subjects covered. The two-color 20-page bulletin may be obtained from the General Electric Co., Schenectady 5, N. Y.

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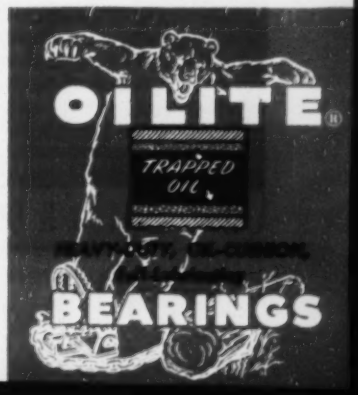


KEEP INFORMED

NEW EQUIPMENT | BUSINESS NOTES | LATEST CATALOGS

Slide Rule Booklet

"A slide rule with intellect and . . . . . horse sense," is the latest booklet in the Don Herold series, published by Keuffel and Esser Co., Adams and 3rd Sts., Hoboken, N. J.

The booklet points up the thinking and planning behind the scale arrangement of the company's Log Log Duplex Decitrig Slide Rule.

Another Don Herold booklet, "So you're going to be an Engineer," is also available from the company.

Electric Platform Truck

Bulletin P-1038A published by the Yale & Towne Mfg. Co., Philadelphia 15, Pa., pictures and gives dimensions and specifications on Yale 4000 and 6000 lb capacity Worksaver low lift electric platform trucks.

Among the features of this truck as depicted in the bulletin are dead man control which automatically cuts off power and applies brake when operating handle is either in full up or full down position, high maneuverability made possible by 16 in. diam turntable with 105 ball bearings and tapered roller bearing support as well as direct gear drive with enclosed gears operating in an oil bath.

Motoreducer Bulletin

A new bulletin No. 3100, published by the Falk Corp., 3001 W. Canal St., Milwaukee 8, Wis., consolidates selection tables, dimensions, weights, overhung load ratings, and thrust capacity ratings needed to select horizontal, vertical or right angle Falk motoreducers in either the all-motor of integral design.

A fold-out section of the 28-page bulletin contains illustrated information on mounting positions, low speed shaft connections and product features, along with pictures of typical applications. Also listed are standard accessories and modifications and data and selection tables on couplings.

Roller Chain, Sprockets

Stock Roller Chain and Sprockets is the title of Catalog 754, a 64-page illustrated book published for distribution by Diamond Chain Co., Inc., Indianapolis, Ind. The catalog covers a complete line of roller chain stock sprockets.

Stocked by distributors in every industrial area, the line includes minimum bore sprockets for reboring as well as finished bore and Taper-lock bushed sprockets which are ready to use. Chain selection and application data is included in the catalog.

Control Valves

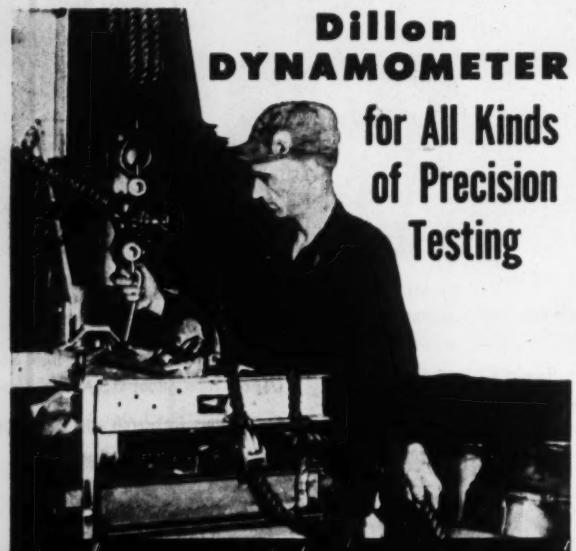
Bulletin 307 published by Ross Operating Valve Co., 120 E. Golden Gate Ave., Detroit 3, Mich., describes and illustrates the company's rotary handle action or "Pancake" valve.

This four-way valve, 2-in. high, has poppet type seals. Bottom ported base plate permits removal of body without disturbing piping. The bulletin contains operation and recommended service information, installation data, parts list and "exploded" view of component parts.

Investment Castings

"How to Design Precision Investment Castings" is a pocket-size booklet made available by Midwest Precision Castings Co., 2790 Grand Ave., Cleveland 4, Ohio. The illustrated book is written as a guide to metal working executives and design engineers who wish a file of both the benefits and limitations of the "lost wax" investment casting process.

The brochure discusses many basic design principles as they apply to the investment casting processes. A materials chart listing physical properties and use of some of the more popular metals is also included.



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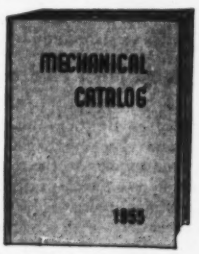

As an ASME member, you recently received a Request Card to be filled in and returned if you wish to receive a copy of the 1955 Mechanical Catalog. Distribution is limited so don't delay returning your card at once. In addition to its comprehensive directory of over 40,000 listings, it contains thousands of detailed product descriptions provided by hundreds of leading manufacturers. Now in its 44th year, Mechanical Catalog is the super market for mechanical engineers. It gives you product facts fast, up-to-date, accurate. If you did not receive your MC Request Card, use your letterhead to reserve a copy right away.

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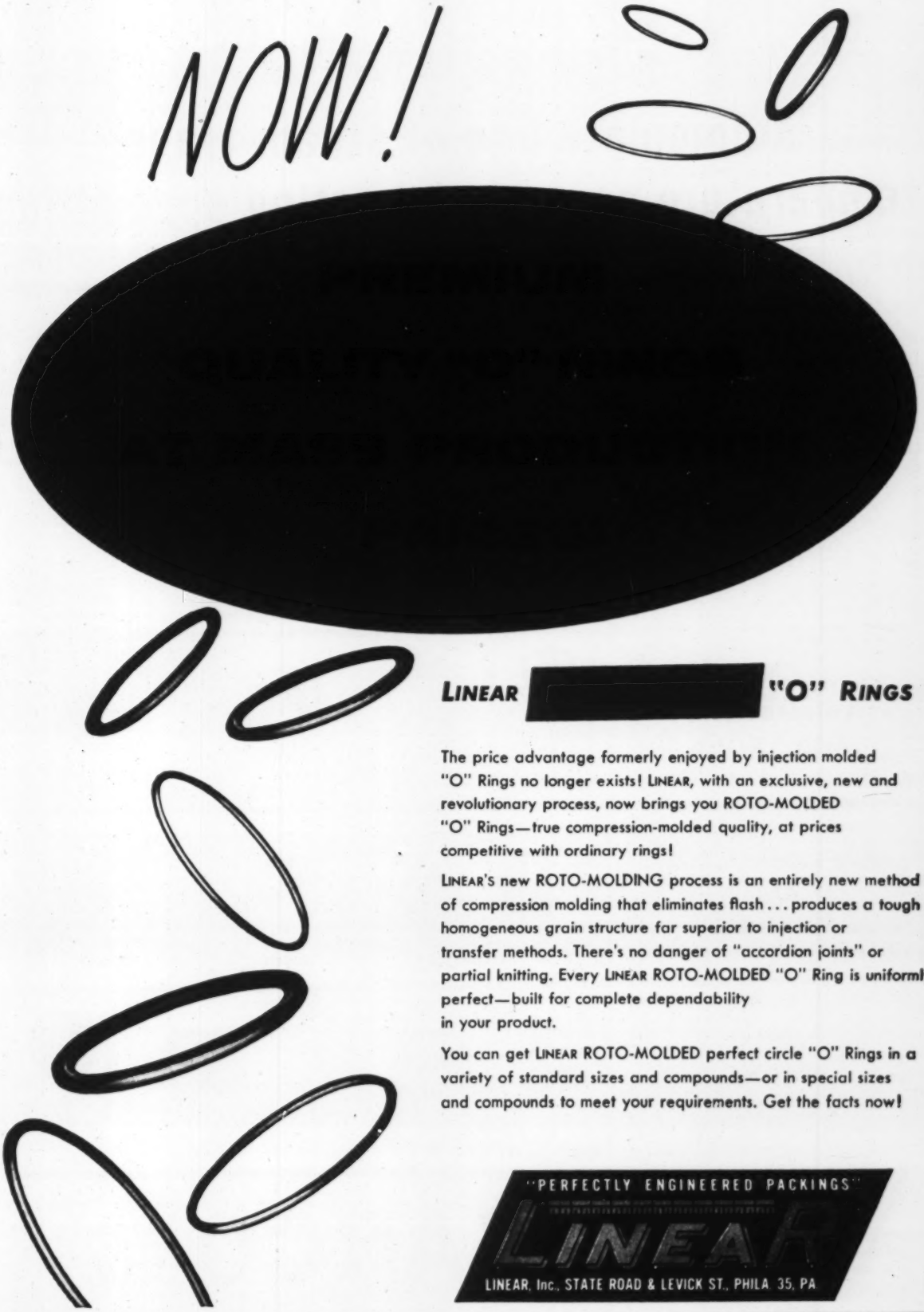

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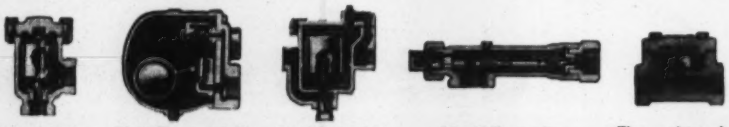

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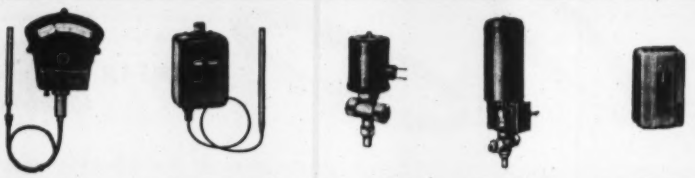

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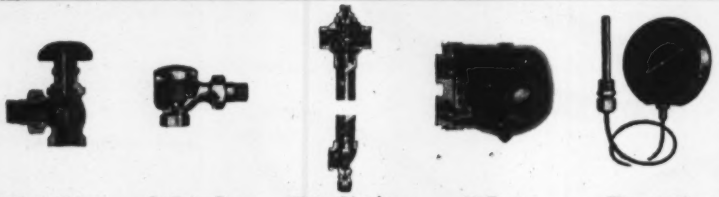

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Send us data concerning your installation; we'll gladly send you bulletins and case histories. Sarco Company, Inc., Empire State Bldg., N. Y. 1, N. Y.

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2071-B

Piping in power, petroleum and processing plants
is designed to move.
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are bound to make changes in dimensions.
So, expansion joints are placed in piping systems . . .
to absorb all such punishing stresses.

Obviously, the very best expansion joint,
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—by from 90% to 1200%—
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So, that's why you should insist
that the Zallea name be on
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both your piping . . . and your pocket book.

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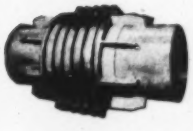

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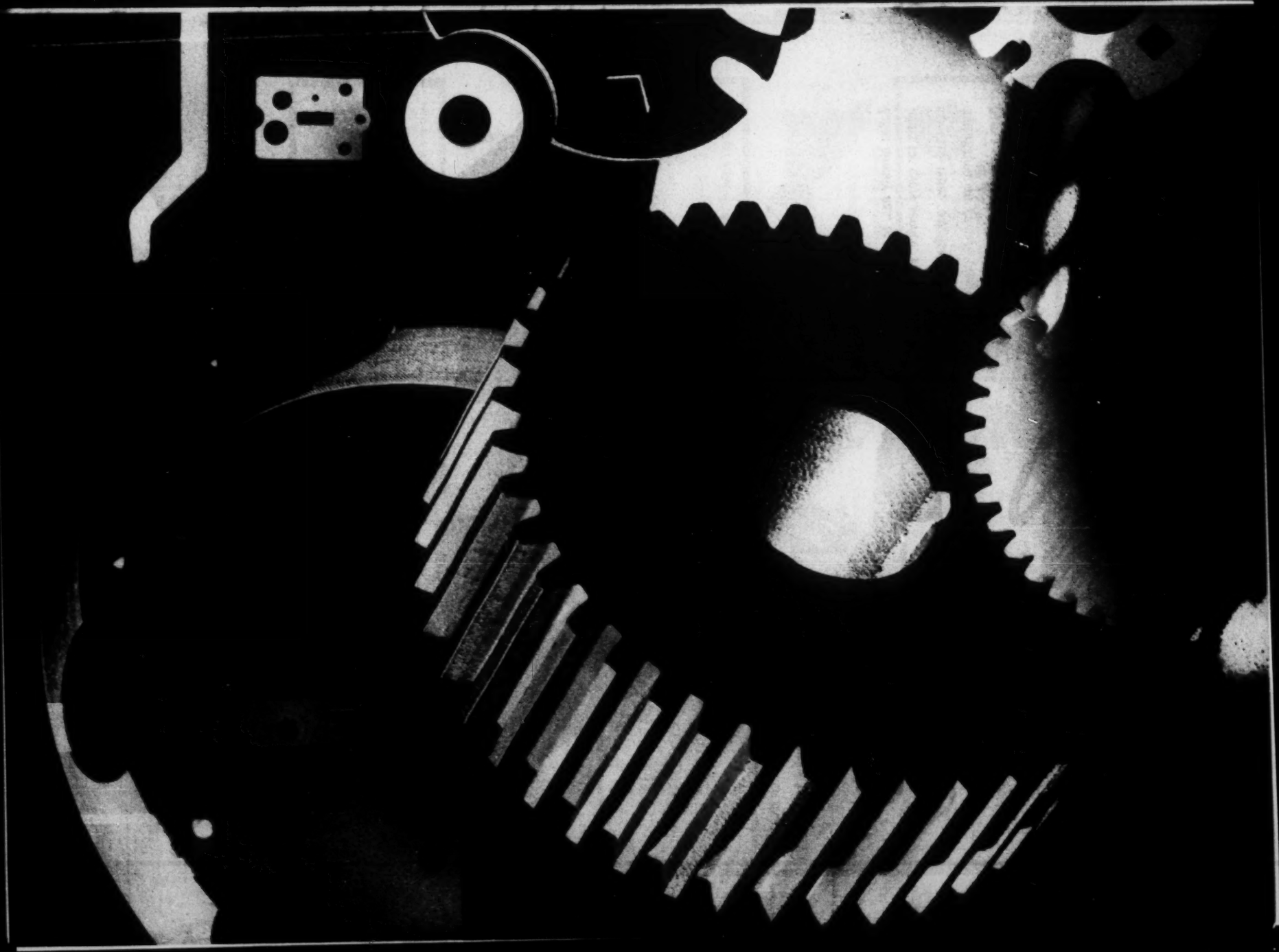

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Today, MICARTA® is serving and saving in thousands of applications all across the industry. You'll find it extensively used in moving parts because MICARTA resists impact, soaks up vibration and muffles noise. You'll see it widely used in structural parts because MICARTA gives strength and rigidity while weighing only half as much as aluminum. You'll spot it in many places employed as an electrical insulator. You'll even come across it in piping systems because MICARTA fights corrosion, repels moisture, endures heat and cold.

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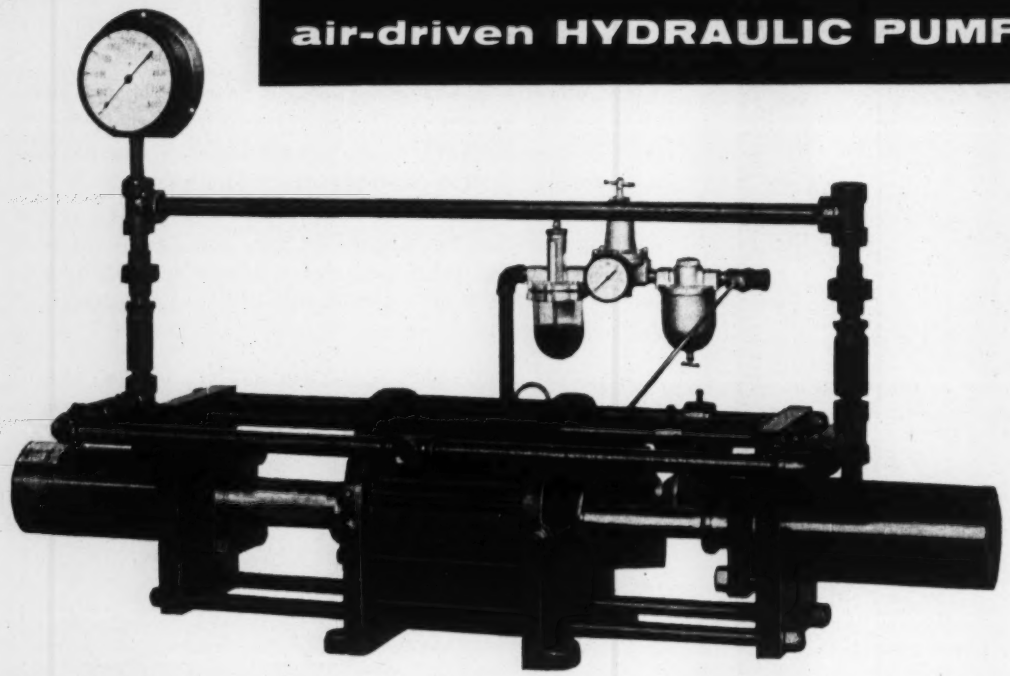

. . . for small volume capacity at low or high pressures

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Special muffler design provides quiet operation.

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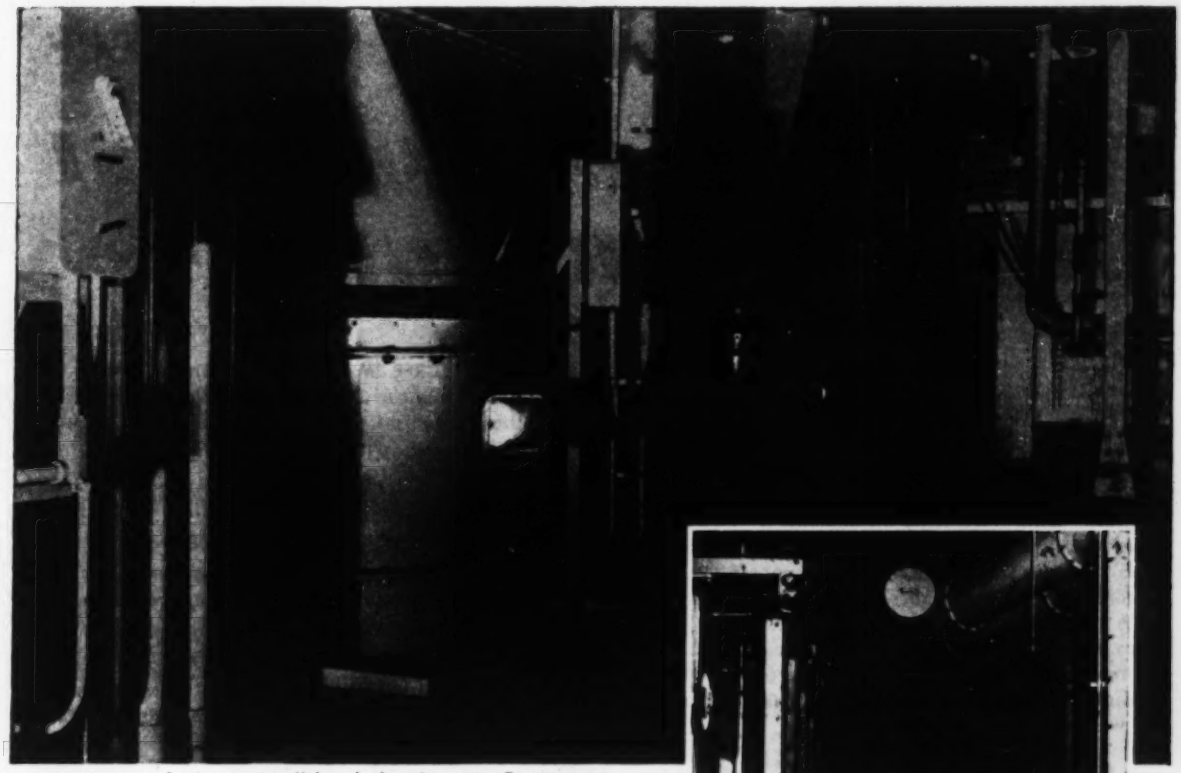
the ALDRICH *pump company*

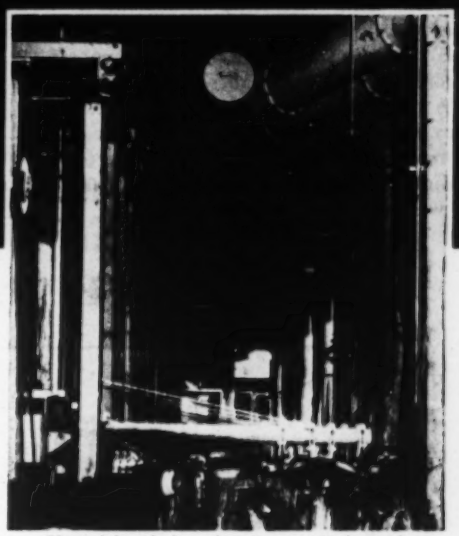
. . . Originators of the Direct Flow Pump

29 PINE STREET • ALLENTOWN, PENNSYLVANIA

Representatives: Birmingham • Bolivar, N. Y. • Boston • Buffalo • Carmi, Illinois • Charleston, W. Va. • Chicago • Cincinnati • Cleveland • Dallas • Denver • Detroit • Duluth Houston • Los Angeles • New York • Oakland, Calif. • Philadelphia • Pittsburgh • Portland, Ore. • Richmond, Va. • Rochester • Salt Lake City • San Francisco • Seattle Somerville, Mass. • Spokane, Wash. • Syracuse • Tulsa • Washington, D. C. • Youngstown • Export: Petroleum Machinery Corp., 30 Rockefeller Plaza, New York 20, N. Y.



Joy fans are installed in the ducts for greater efficiency, easier installation, and economy of floor space.



Vertical branch ducts draw fumes into the trunk line for ultimate discharge into the atmosphere.

PLATING LINE VENTED BY JOY AXIVANE® FANS

Corrosive Air Removed in Jig-time By "In-the-Duct" Installation of Exhaust Fans

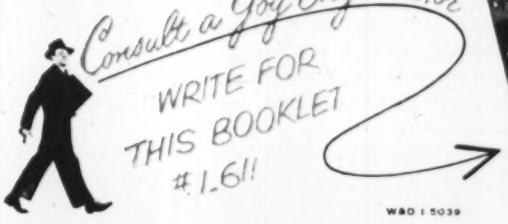
An interesting, and necessary, feature of the new zinc and cadmium plating line at Appleton Electric Company, Chicago, is the compactness of the Joy Axivane Fan exhaust system.

This exhaust system carries off the hot, corrosive air from the plating line up to the roof where it is discharged into the atmosphere.

Centrifugal units would have necessitated an expensive modification in the building structure, in addition to a larger, more complicated duct system.

The compact, in-line design of the Joy Axivane Fans permitted installation *right in the ducts* on the floor above the plating line. Floor space was saved, installation costs were drastically reduced, building structure did not have to be altered, and a much smaller and simpler duct system was constructed!

Joy Axivane Fans will show you new standards in efficiency, compactness, quietness, and outstanding versatility. There are 136 models . . . all with adjustable blades . . . for volumes up to 300,000 CFM and pressures to 11″ wg. Get the full story on Joy Fans by writing for Bulletin J-611, TODAY. ***Joy Manufacturing Company, Oliver Building, Pittsburgh 22, Pa.*** In Canada: *Joy Manufacturing Company (Canada) Limited, Galt, Ontario.*

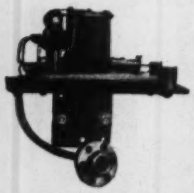


JOY

SPECIALISTS IN THE COMPRESSION AND MOVEMENT OF AIR AND GASES SINCE 1885

Now you can measure pressures

WITHIN ½% OF 20-40 PSI SHIFTABLE RANGE SPANS



The Taylor TRANSAIRE* Pressure Transmitter with short, shiftable spans gives accuracy and sensitivity never before thought possible—plus the convenience of suppressed ranges at high pressure levels. Operating on the simple force-balance principle, it lets you measure and transmit minute pressure changes up to 1,000 ft. It's accurate to ½% of the selected short range span, as against an accuracy of up to ½% of the upper range limit of conventional devices. On control applications such accuracy of measurement produces a remarkable difference in product quality and yield. It's sensitive to pressure changes of ½" water.

THREE IMPORTANT ADVANTAGES

1. Range spans of 20 and 40 psi are available throughout the range limits of 35 to 415 psia; 50 to 100 psi throughout 100 to 1,000 psia.

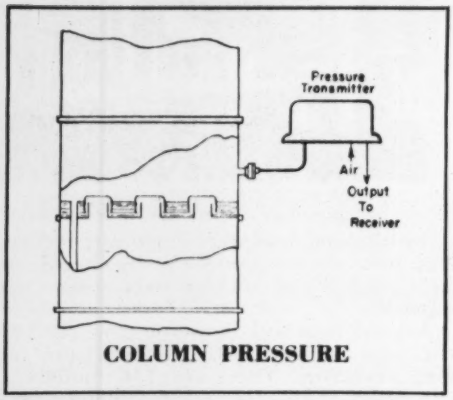
2. The volumetric type pressure system is extremely accurate, practically clog-proof, has a corrosion-resistant 316 stainless steel diaphragm.

3. Temperature and barometric compensation makes for higher accuracy of measurement, and consequntly closer control.

• • •

Ask your Taylor Field Engineer, or write for **Bulletin 98097.** Taylor Instrument Companies, Rochester, N.Y., and Toronto, Canada.

TRANSAIRE PRESSURE TRANSMITTER



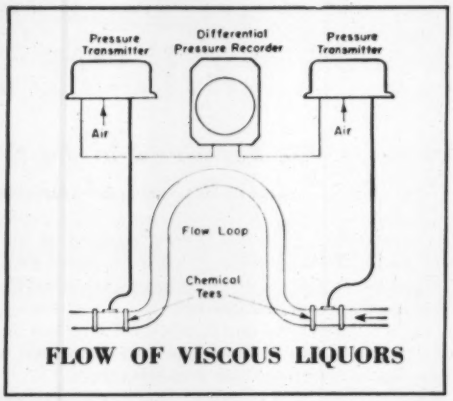
COLUMN PRESSURE

NARROW RANGE SPAN DETECTS PRESSURE TRENDS

Problem: To get highest possible purity of product consistent with good production economy. This requires the quick detection of pressure trends over a very narrow range.

Solution: The short, shiftable range spans (as short as 20 psi) of the TRANSAIRE Pressure Transmitter permit selection of operating range by a simple screwdriver adjustment. Its high order of sensitivity enables the operator to detect minute changes of pressure.

Result: Close control, because the minute pressure trends are practically instantaneously detected and transmitted to the controller and receiver. This means higher yield of a purer product, also great flexibility in changing to different product requirements.



FLOW OF VISCOUS LIQUORS

STREAMLINED SURFACE PREVENTS SCALE, SOLIDIFICATION

Problem: Flow measurement of viscous material which tends to solidify when static, making conventional differential producers impractical.

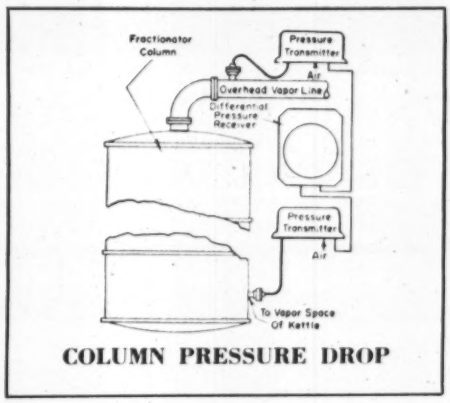
Solution: Its flush element presents a streamlined surface and tends to prevent formation of scale or solidification of liquors. Its short range, high sensitivity and volumetric construction make the TRANSAIRE Pressure Transmitter ideal for this application.

Result: Trouble-free, accurate measurement and control of flow. One installation has given continuously satisfactory service for four years.

*Reg. U.S. Pat. Off.

Typical installation of a TRANSAIRE Pressure Transmitter on a distillation column. Note close-coupled connection in field. Receiver may be several hundred feet away.

SOLVED THESE FOUR TOUGH PROBLEMS



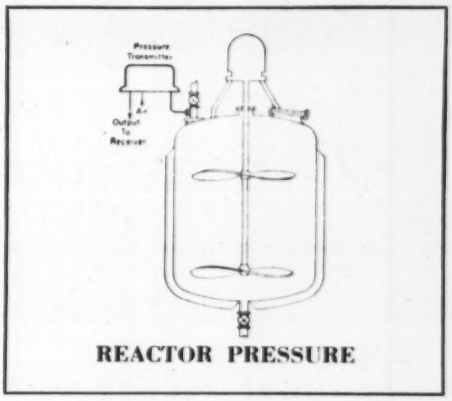
COLUMN PRESSURE DROP

PERMITS MAXIMUM CAPACITY OPERATION

Problem: To operate a column at maximum capacity, consistent with the preventing of flooding.

Solution: As the pressure drop across the column is a measure of the vapor velocity, the measurement of this drop with a short-range, highly sensitive, easily adjustable instrument enables the operator to keep the column safely close to the flooding point.

Result: Maximum production and uniform operation.



REACTOR PRESSURE

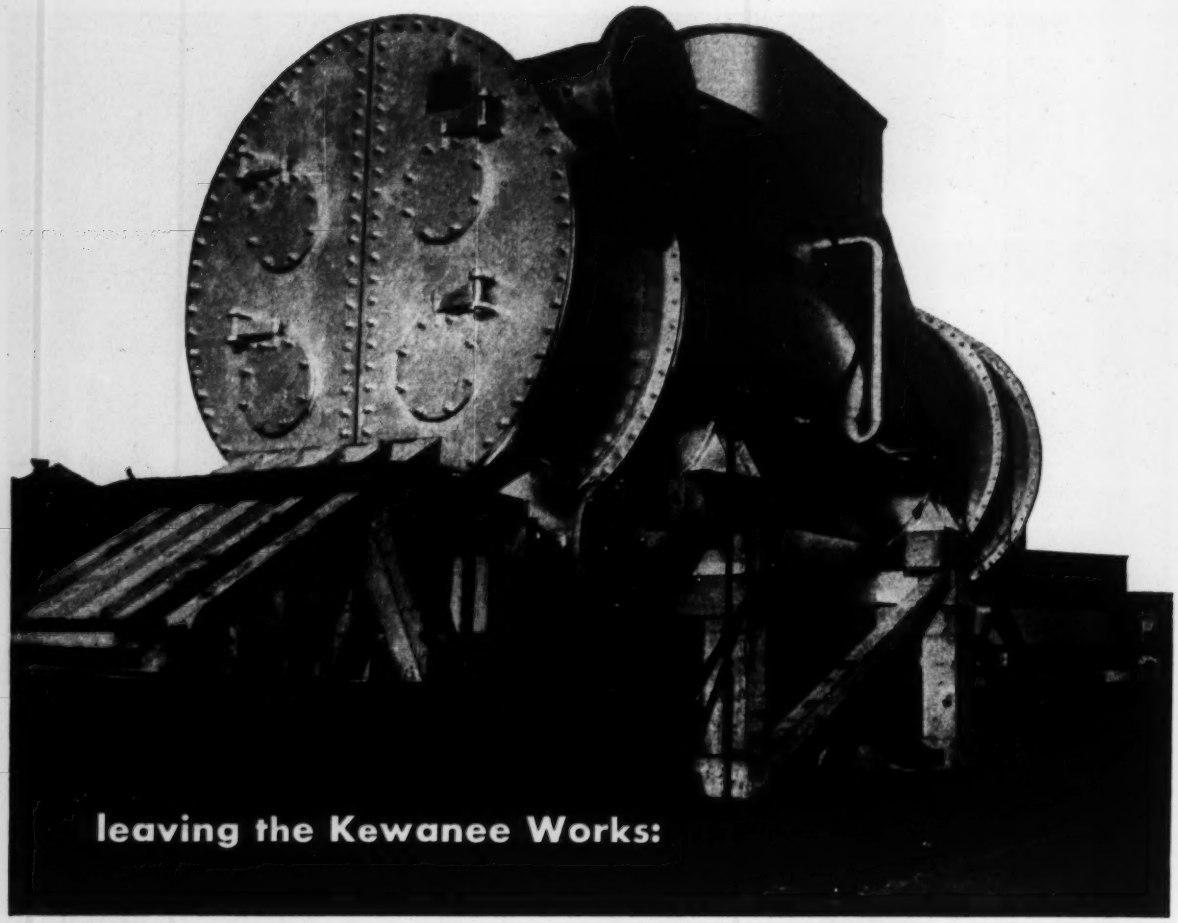
FLUSH SURFACE IS CLOG-PROOF

Problem: To measure pressure in reactor kettles containing viscous or corrosive liquids which tend to clog conventional measuring systems.

Solution: The closed volumetric measuring system of the TRANSAIRE Pressure Transmitter presents a flush surface on the inside of the vessel. It is clog-proof, highly sensitive and provides an accurate reading.

Result: Maximum yield of high purity product and a precise knowledge of the pressures maintained.

Taylor Instruments MEAN ACCURACY FIRST



ROSS SURFACE CONDENSERS TRAVEL TO ALL CORNERS OF THE WORLD

Leaving the Kewanee, Ill. plant, this Ross Surface Condenser is one of a pair bound for New Mexico. It's a relatively short trip compared to the distances that many Ross units have traveled to reach countries such as Australia, Brazil, Iran, Aruba, Sumatra . . . mentioning but a few. Their efficiency and dependability have been proved in remote and isolated locations all over the world.

The reason Ross Surface Condensers are widely preferred, for installations both in the U. S. and foreign countries, can be expressed in two words: *advanced engineering* . . . engineering that introduced the first all welded steel surface condenser at Parr Shoals, S. C. in 1929 and pioneered numerous other developments, including Balanced Flow and divided tube bank design.

It's only logical then, that Kewanee-Ross is best qualified to meet *your* surface condenser requirements, too. Consultation with Kewanee-Ross engineers will leave you assured of this.

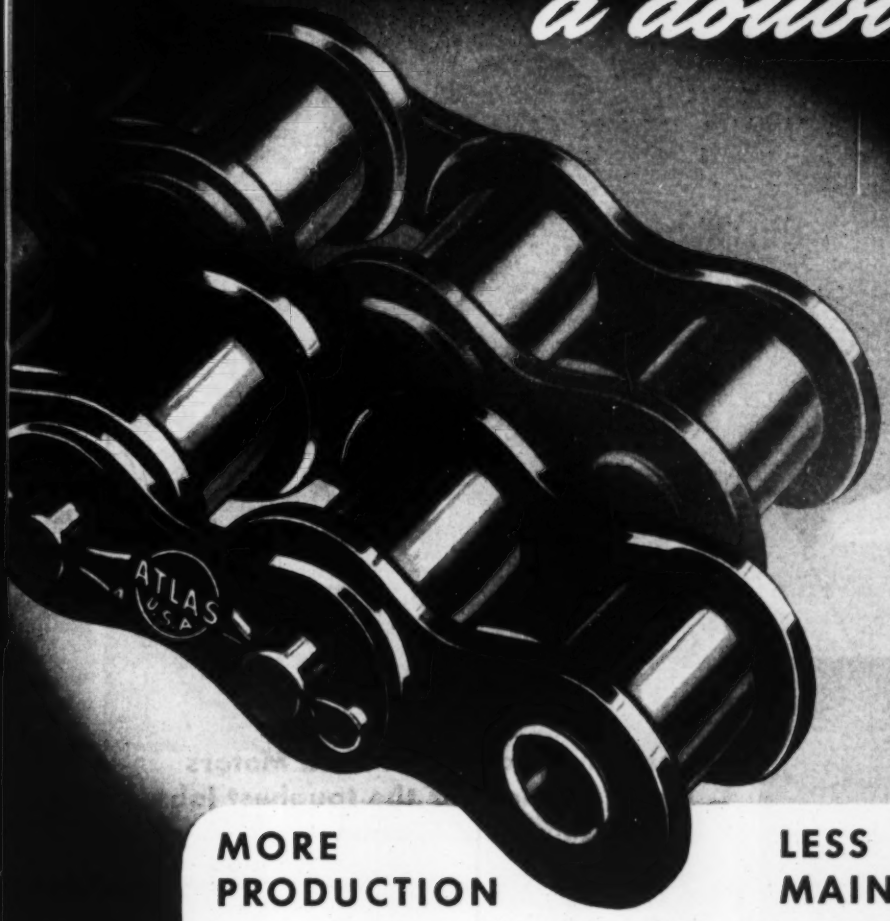
KEWANEE-ROSS CORPORATION
DIVISION OF AMERICAN RADIATOR & STANDARD SANITARY CORPORATION
1448 WEST AVENUE • BUFFALO 13, N. Y.
In Canada: Kewanee-Ross of Canada Limited, Toronto 5, Ont.

ROSS SURFACE CONDENSERS

Serving home and industry: AMERICAN-STANDARD • AMERICAN BLOWER • CHURCH SEATS & WALL TILE • DETROIT CONTROLS • KEWANEE BOILERS • ROSS EXCHANGERS • SUNBEAM AIR CONDITIONERS

CHAIN THAT LEADS

a double life!



MORE PRODUCTION

Boosting output of present drives! Atlas Roller Chain is bringing this benefit to plants everywhere.

That's because Atlas Roller Chain provides a positive sprocket grip which makes possible the delivery of full rated horsepower without slippage or friction.

This means that your machines can run at full rated speeds and give greater output . . . with Atlas on the drive.

LESS MAINTENANCE

Here's why: The bushings and pins are case hardened by the Atlas Nicarb Process which provides greater inherent strength. Link plates and rollers are also made of tough, heat-treated alloy steel.

This means better chain performance . . . less chain maintenance.

For maximum production plus long, trouble-free service, install Atlas Roller Chain! Write today for the new Atlas Catalog and Handbook No. 52-ME.

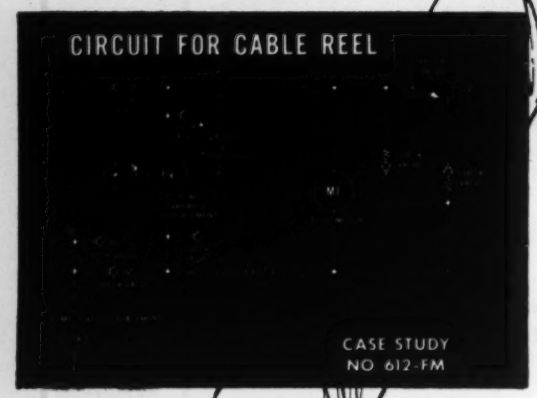
ATLAS CHAIN & MANUFACTURING CO.

DIVISION OF PRUDENTIAL INDUSTRIES

DOYLESTOWN, PENNA.

ATLAS ROLLER CHAIN

Shock loads can't hurt this fluid motor



Denison Axial Piston Fluid Motors recommended for the toughest jobs . . . without qualification

Quick starts, quick stops, stalling under load, continuous braking. These are the kind of conditions Denison Fluid Motors are built for. Where other motors fail, Denison hydraulic motors operate continuously . . . in conveying equipment, mining, drilling, construction machinery.

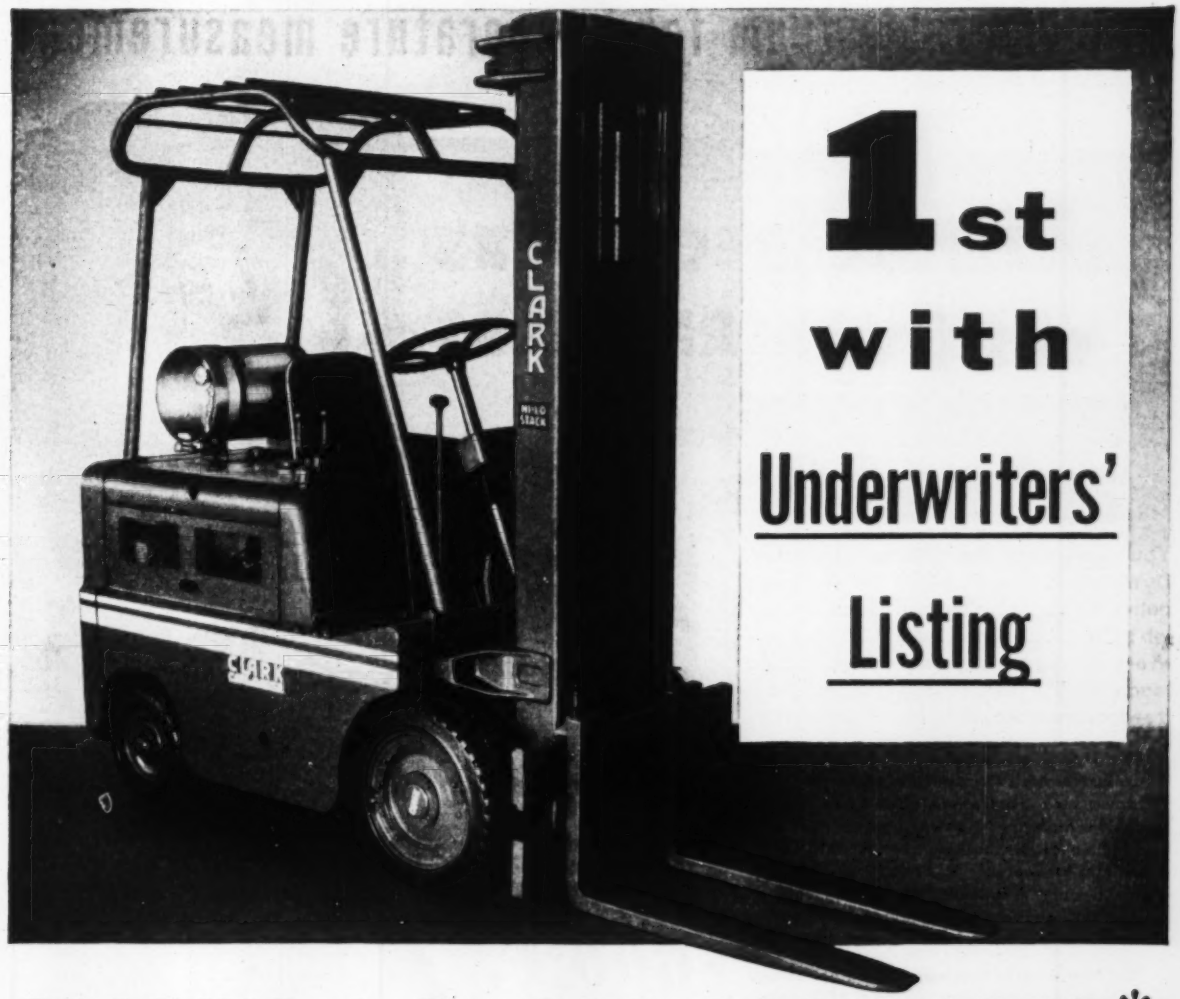
Through efficient axial piston design, Denison hydraulic motors pack high horsepower, high torque in a smaller space. The 400 series fluid motor is less than a foot long, weighs only 40 pounds . . . yet delivers 24 horsepower.

Denison Fluid Motors can be furnished to develop up to 180 horsepower, 5665 pounds-inches torque . . . for any hydraulic circuit to 5000 psi.

The circuit shows a Denison Fluid Motor that reels cable in and out of oil wells. For bulletins about Denison Fluid Motors, write to: THE DENISON ENGINEERING COMPANY, 1174 Dublin Road, Columbus 16, Ohio.

PUMPS • MOTORS
CONTROLS • PRESSES

DENISON
Hydr OIL ics



CLARK'S L.P.-GAS CARLOADER*

reduces engine maintenance, eliminates obnoxious exhaust fumes

1. Greatly reduces engine maintenance:

——eliminates unburned carbon deposits and crankcase dilution.

——eliminates fuel pump and complicated carburetor adjustments.

2. Eliminates obnoxious exhaust fumes:

——L.P.-Gas provides almost perfect combustion, excellent for indoor operations.

3. Provides safe, efficient operation:

——vacuum ignition switch is interlocked with fuel line and manifold, impossible to spill fuel or load-up engine.

——high compression head (8.5 to 1) gives maximum economy and power from high octane L.P. Gas.

——quickly demountable tank takes 3 minutes to change.

——Stellite valves and seats prevent burning from high flame temperature of L.P. Gas.

*4000 lb. capacity, available with standard shift, Hydratork or Dynatork.

Now you can have the advantages of liquified petroleum gas-powered (butane, propane) materials handling, with complete safety. The Clark L.P.G. Carloader is the first lift truck to receive the all-important listing of Underwriters' Laboratories. Field and factory tested for two years, Clark's unit is specifically designed and metered for fork truck operation. For details, call your local Clark dealer, listed under "Trucks, Industrial" in the Yellow Pages. Or send the coupon for specifications.

CLARK EQUIPMENT

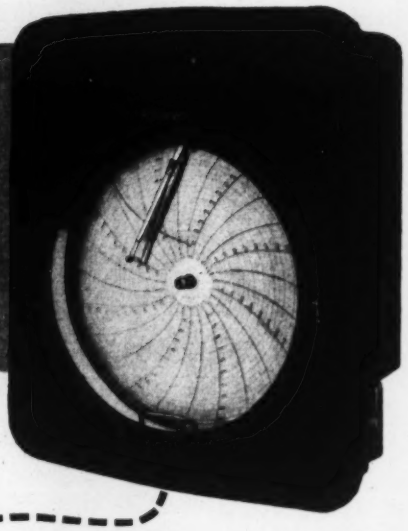
Industrial Truck Division
CLARK EQUIPMENT COMPANY
Battle Creek 88, Michigan

☐ Send details on LPG truck

Name_____
Firm_____
Address_____
City_____

An unbeatable team for temperature measurement

DYNALOG RECORDERS and DYNATHERM BULBS



You can't beat this Foxboro Dynalog-Dynatherm combination for insuring better temperature measurement on any job between–100° and+600°F. It gives you every advantage of speed, accuracy, long leads, simple installation, economy, and freedom from maintenance. This is why:

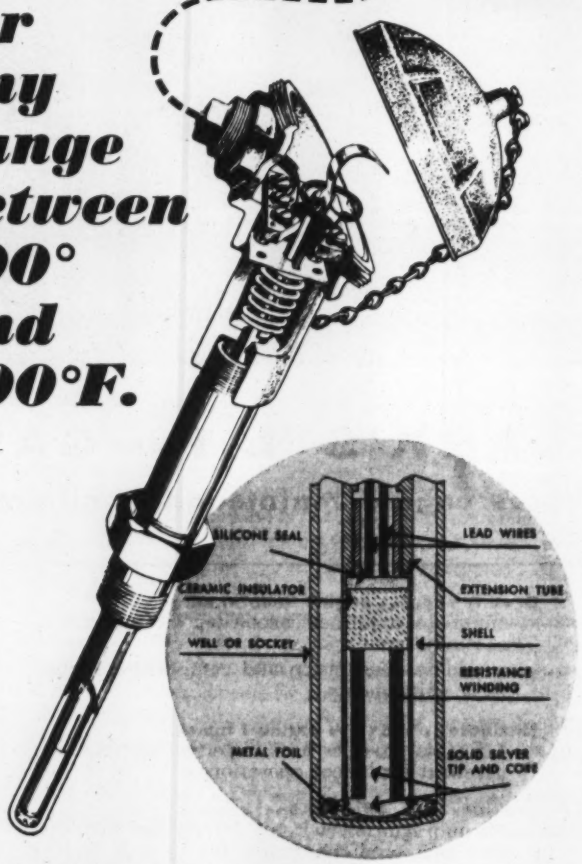
The Dynalog Electronic Recorder has an exclusive variable-capacitor measuring system which eliminates slidewires, gears, cables, high speed balancing motors . . . no dead space, no batteries to standardize, no motors to service. Standard full-scale pen speed only 3 seconds. Sustained accuracy ¼ of 1% guaranteed. Available for spans as narrow as 5°F. with full-accuracy calibration.

The Dynatherm Resistance Bulb has unique features including metal-to-metal end-contact which, when installed in a well or socket, gives a speed of response unsurpassed by any other similarly protected temperature-sensitive element. Exceptionally rugged and permanent in calibration.

These are only a few of the important advantages of this better temperature measuring system . . . available also for control of temperatures, or with Multi-Record Dynalog Recorder for up-to-6 records on one chart. Write for illustrated bulletins.

The Foxboro Company,
939 Neponset Ave.,
Foxboro, Mass., U.S.A.

for any range between -100° and +600°F.



FOXBORO INSTRUMENTATION

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND

Trabon

AUTOMATICALLY LUBRICATES YOUNGSTOWN MILL

.....and cuts MAINTENANCE *to the bone!*

After the first four months of operation, the only maintenance on TRABON'S automatic lubrication system, recently installed on the Youngstown Sheet & Tube Company's 44" blooming and slabbing mill, was the replacement of two hoses in an unusually hot spot.

Bearings were in good shape after the rolling of 238,100 tons. Everyone was pleased with the production record.

We were, too, because this installation proved once again that a Trabon system can deliver just the right amount of oil or grease at just the right time in exactly the right place.

And a Trabon system does this job under the worst possible operating conditions . . . dirt, steam, ice, heat . . . *positively!*

What's YOUR lubrication problem? Write for our current detailed literature.

Pertinent FACTS

- **Automatic oil system lubricates screws, breaker blocks and nuts.**
- **Automatic grease system lubricates roll necks and chuck slides; front and rear table drives, manipulator and feed roll bearings in mill housing.**
- **All pumps in cellar.**
- **Control boxes in engine room.**
- **Lights and warning horns included.**

TRABON automatic lubrication has a *BEARING* on the subject of production

Trabon

ENGINEERING CORPORATION

1814 E. 40th STREET • CLEVELAND 3, OHIO

Oil and Grease Systems

In a variety of corrosive services

BYERS WROUGHT IRON

serves longer at lower cost per year

The true cost picture isn't given by construction costs alone. It must include *maintenance* costs also . . . and when these are included, the most durable materials have proved themselves as the most economical.

You'll find Byers Wrought Iron Pipe and plate the best material to use when you are building for permanence. The illustrations show a few of the many applications where it is serving successfully for others . . . and where it can serve and save for you. The use of wrought iron *adds only a trifle to the overall cost* of a project, and this small investment is returned many times over in extra service.

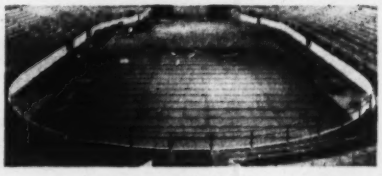
Wrought iron lasts longer, at lower cost per year because of its unique structure which resists corrosion and fatigue. Tiny fibers of glass-like iron silicate, distributed through the body of high-purity iron, halt and detour corrosive attack, discourage pitting and rapid penetration. These fibers also anchor the initial protective scale, which shields the underlying metal.

Our booklet, *The ABC's of Wrought Iron,* tells the story of this protection, and how it is bringing piping economy to a variety of applications where corrosion is a threat. Write for your copy.

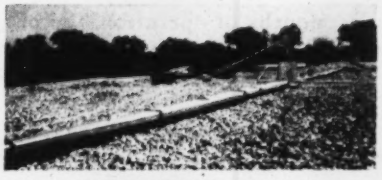
A. M. Byers Company, Pittsburgh, Pa. Established 1864. Boston, New York, Philadelphia, Washington, Atlanta, Chicago, St. Louis, Houston, San Francisco. Export Department: New York, N.Y.

HEATING LINES

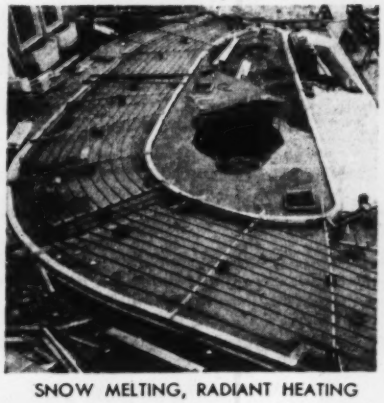
UNDERGROUND LINES



ICE RINKS

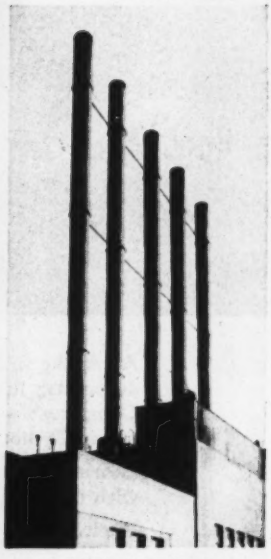


WATER WORKS, SEWAGE



SNOW MELTING, RADIANT HEATING

PLUMBING LINES



STACKS, BREECHINGS

AIR CONDITIONING SYSTEMS

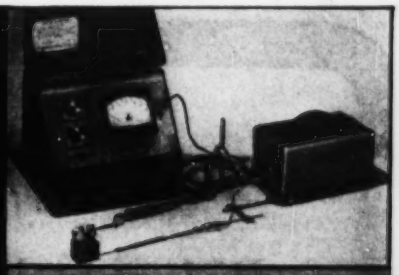
BYERS

CORROSION COSTS YOU MORE THAN WROUGHT IRON

WROUGHT IRON

TUBULAR AND HOT ROLLED PRODUCTS

ELECTRIC FURNACE QUALITY STEEL PRODUCTS



SURFINDICATOR*
meets every surface measurement problem

The standard pickup for the SURFINDICATOR is hand operated, permits measurement of virtually all shapes, from ¼" O.D. to ¼" I.D. The new accessories shown above—motor drive and small bore adapter—extend the usefulness of the instrument. Motor drive speeds inspection where large numbers of identical parts are involved. Adapter permits measurements in very small diameters—as small as ⅛" I.D.—and other limited areas.

*Trade Mark

See how easy it is to measure **SURFACE ROUGHNESS**

Time-consuming laboratory setups to determine surface roughness are now a thing of the past. With the Brush SURFINDICATOR* you can check surface roughness instantly – anywhere –even when the part is mounted in a machine tool as shown above.

The new ease of measuring surface roughness permits you to control this production variable—which affects machining costs, appearance, friction, wear, product life and many other characteristics. Finish can be specified in blueprints and quickly checked in the shop. The operator simply guides the pickup over the surface and reads roughness in microinches directly on the meter. No calculations are required and accuracy of the instrument can be checked at any time against Precision Reference Standards.

TRY IT YOURSELF! Write for a copy of this booklet on Surface Finish Control. Or, ask for a demonstration of the SURFINDICATOR in your plant by a Brush engineering representative. Send coupon now. Brush representatives are located throughout the U. S. In Canada: A. C. Wickman, Limited, Toronto. Brush Electronics Company, Cleveland 14, Ohio.

BRUSH ELECTRONICS COMPANY

INDUSTRIAL AND RESEARCH INSTRUMENTS
PIEZO-ELECTRIC MATERIALS • ACOUSTIC DEVICES
MAGNETIC RECORDING EQUIPMENT
ULTRASONIC EQUIPMENT

BRUSH 6 ELECTRONICS

formerly
The Brush Development Co.
Brush Electronics Company
is an operating unit of
Clevite Corporation.

Brush Electronics Company, Dept. P-9
3405 Perkins Avenue, Cleveland 14, Ohio

☐ Please send free copy of "Surface Finish Control".

☐ Have your nearest representative demonstrate the Surfindicator to me.

Name .....

Position .....

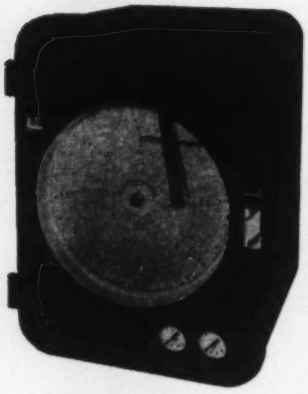
Company .....

Address .....

City ..... *State* .....

for

Reliable Measurement of low differentials



HAGAN

RING BALANCE METERS

Where flow measurements *must* be made with a low full scale differential, the logical choice is the Hagan Ring Balance Meter. This versatile meter, with no external sealing chambers, is equally useful for flow measurements at low differential or high differential, at high or low pressures.

Consider these advantages of the Hagan Ring Balance Meter

Interchangeable sensing elements, in a complete series, are available for measuring full scale differentials from 1″ to 420″ WC, at static pressure up to 3,000 psig.

The ring assembly is selected for each installation to assure ample power for accurate meter operation at all flows.

The differential range of any ring is adjustable over a 7 to 1 ratio.

The level of sealing fluid in the ring is not critical, the only requirement being sufficient depth to seal against maximum differential.

Calibration, using dead weights, takes only a few minutes. It is not necessary to disconnect the meter from the line.

Automatic compensation for such variables as temperature, pressure or fluid density is a standard attachment.

Pneumatic or electric signal transmission is available for remote recording or automatic control.

The Hagan Ring Balance Meter is the most versatile design available for flow measurements with any source of differential—orifice plate, venturi tube, pitot tube, weir or flume.

We will be glad to suggest the metering equipment best suited for improving existing facilities, or for extensions and new construction.

HAGAN HALL BUROMIN CALGON

HAGAN CORPORATION

Hagan Building • Pittsburgh 30, Pennsylvania

Boiler Combustion Control Systems • Ring Balance Flow and Pressure Instruments • Metallurgical Furnace Control Systems Control Systems for Automotive and Aeronautical Testing Facilities

An important message concerning a new —and unique— alloy steel

UNITED STATES STEEL is pleased to announce to all steel consumers a new steel which we feel sure will enable you to improve the performance, lengthen the life, and reduce the cost of industrial equipment. This new engineering material is USS Carilloy T-1 steel, which recently underwent some very severe testing in Birmingham, Alabama.

The development of T-1 steel began back in 1947, when our research people took a good look at a problem that had plagued alloy plate steel users for years. That problem was the multiplicity of compositions required to do everyday jobs. There was no one composition available that could serve a wide variety of applications—so our research people set out to develop such a steel. The steel we wanted had to possess many unusual attributes such as very high strength, unusual toughness, good weldability and excellent resistance to impact abrasion at temperatures from minus 150°F. up to as high as 900°F.

Today such a steel is a reality. It is USS Carilloy T-1 steel, which has been tested thoroughly, both in the laboratory and in actual service applications. To prove further the capabilities of this new Carilloy steel, Chicago Bridge & Iron Company and United States Steel this summer carried out a joint testing program on commercial pressure vessels built from T-1 steel. The results of these tests and their significance to all steel users are described on the next three pages. We feel sure that you will find the story well worth reading.

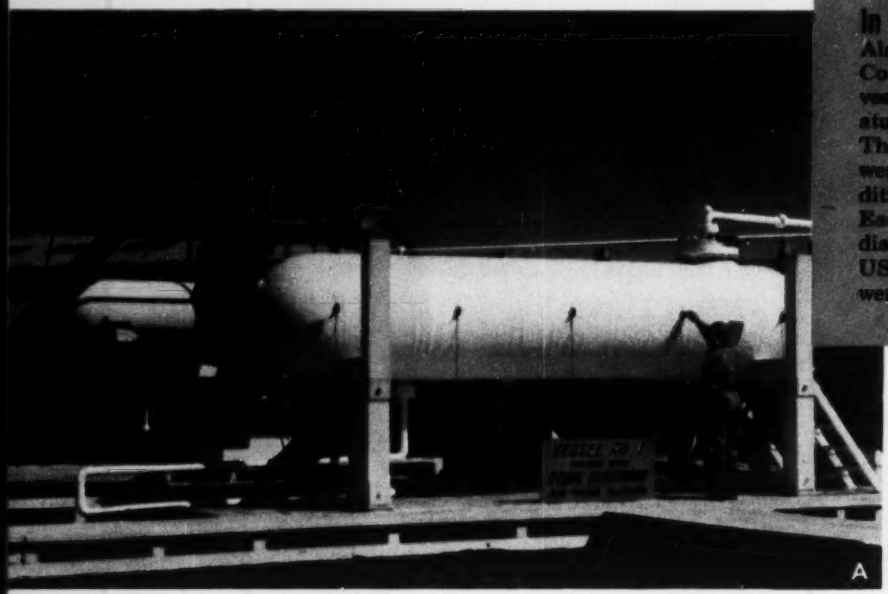
USS

UNITED STATES STEEL

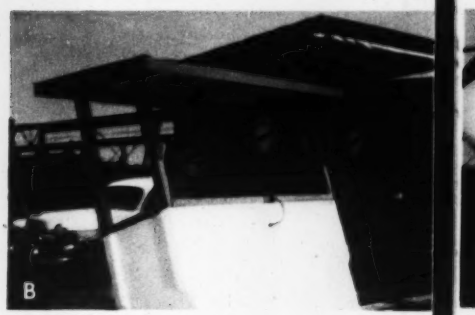
Remarkable new engineering material

PROVES SUPER-TOUGH

In May and June, 1954, at the Birmingham, Alabama, plant of Chicago Bridge & Iron Company, eight welded cylindrical pressure vessels were refrigerated to subzero temperatures and deliberately tested to destruction. The vessels were all standard designs that were built under normal production-line conditions by Chicago Bridge & Iron Company. Each vessel was twenty feet long, four feet in diameter, and made of half-inch plates of USS Carilloy T-1 steel. Four of the vessels were welded without stress relieving, using



A



B

In pressure test at 38°F. below zero T-1 steel withstands stresses 3 times its design strength

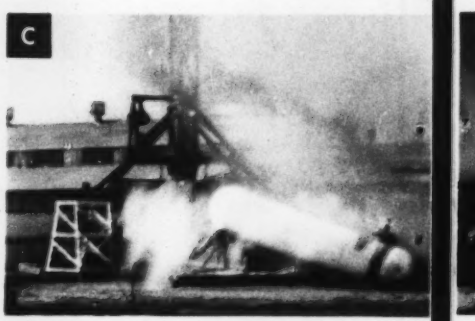
This vessel, not stress relieved, was refrigerated to −45°F. Then, with a quarter inch of white frost clinging to its sides, a high pressure pump slowly chugged the pressure in the vessel up to 938 psi. At that point, the steel itself was stressed to 45,000 psi., which is one half the yield strength of T-1 steel.

The hydraulic pressure was forced still higher, to 1875 psi. At this pressure, the stress in the steel had reached 90,000 psi.—the full *nominal* yield strength. Still, every inch of the metal was sound and all welds were intact.

Now the test really came. The pump labored on, and the pressure climbed to 2,000 psi. . . . to 2500 . . . to 2850 psi. . . . then . . .

BOOM! A jet of yellow brine burst out of the vessel and shot 200 feet through the air. The vessel finally failed at a pressure of 2850 psi. and a minimum stress of 136,000 psi. on the plates. This stress is well over three times the design strength of 45,000 psi.

The temperature of the steel at the time of failure was a frigid 38 below, yet the metal showed no sign of brittle failure. Super-tough USS Carilloy T-1 did what no ordinary steel could do at such a low temperature—it stayed *tough and ductile;* in fact it actually stopped the tear from propagating any further through the vessel.



C

D

USS

UNITED STATES STEEL

USS CARILLOY T-1 STEEL

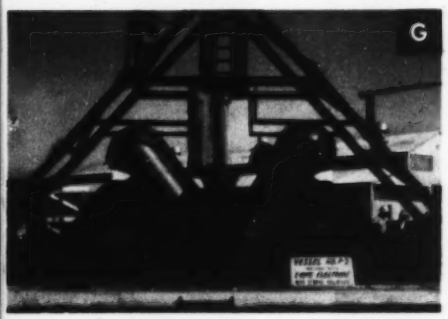
DOWN TO 38°F. BELOW ZERO

E 12015 low hydrogen coated electrodes. The other four were welded with E 8015 electrodes and were stress relieved after welding. Two vessels of each type were given two tests: a pressure burst test for strength and ductility, and an impact punishment test for toughness and resistance to the most severe impact conditions that could be devised.

Results of these tests, described below, prove conclusively the exceptional strength and toughness of USS Carilloy T-1 steel, even at temperatures far below freezing.

E

F


G

H

Frozen steel vessel made of Carilloy T-1 survives blow from 13-ton ingot dropped 73 ft.

A steel ingot weighing 26,700 lbs. has just plummeted 52 feet and crunched on top of this test vessel (Fig. E). The ingot was traveling 39 miles per hour when it hit. It struck with an impact energy of about 1,400,000 ft. lbs., bounced fifteen feet, and crushed down again on top of the vessel.

This vessel was welded without stress relieving. It was refrigerated to 33°F. below zero. It was pressurized to 1,875 psi. equal to a stress on the plates of 90,000 psi.—the steel's *nominal* yield strength. Yet, it did not fail. The ingot left only a 7/16 inch dent in the top, with a slight bulge on either side of the dent.

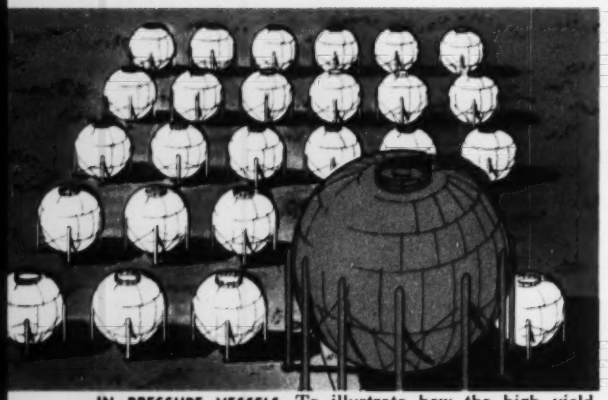
The test was repeated (Fig. F). This time the ingot was raised 73 feet, then dropped. It pounded down again on the very same spot on top of the vessel. Traveling at 46.7 miles per hour, it hit with an impact blow of 1,960,000 ft. lbs. The dent merely deepened – the steel and all welds were still intact.

Again the test was repeated (Fig. G). Now dropped from 101 feet, the 13-ton ingot ploughed into the top of the vessel at a speed of 55 miles per hour, hit with an impact of 2,750,000 ft. lbs. This time the vessel failed. But it didn't shatter. It didn't crack. It tore open like a tough piece of hickory. In other words, it failed without any signs of brittleness, even though the temperature of the steel was now minus 22°F.

In addition to this tremendous resistance to impact abuse, combined with remarkable sub-zero toughness, Carilloy T-1 steel also gives you excellent resistance to impact abrasion . . . good high temperature strength . . . and exceptional weldability.

Turn the page to see how you can use this remarkable new steel to cut costs and improve performance in a great variety of products.

Here's where you can reduce costs with USS Carilloy T-1 steel



IN PRESSURE VESSELS. To illustrate how the high yield strength of Carilloy T-1 steel can pay off here, consider this fact: To store 25,000 bbls. of propane at 210 psi would ordinarily require 25 mild carbon steel vessels. In contrast, only *one* large vessel made of T-1 steel of the *same* thickness would do the job. This single T-1 vessel would require 1/3 less shell material, 14% less foundation concrete, 70% less welding and 84% less space.

IN STEEL MILLS. In skip cars, T-1 steel in the bottoms, sides, and bail plates lasts three times longer than steels now in use. T-1 steel also gives exceptionally long service in coke bins and chutes, in ore transfer cars, in draft lines, in conveyor chains, and crane hooks. In clamshell buckets, T-1 steel has taken heavy abuse at temperatures from 500° to 600° F. and lasted *nine times* as long as the wear resisting steel previously used.

IN EXCAVATING EQUIPMENT. The dipper stick, bail, and bucket of this big electric shovel are fabricated of T-1 steel plate. The superior strength and durability of Carilloy T-1 made it possible to increase the capacity of the bucket from 35 to 45 cu. yds.

• The pressure vessel tests described on the previous pages indicate only one of the many possible uses of Carilloy T-1 steel. For this new engineering material has advantages not only in pressure vessels and storage tanks, but it also has proved itself in power shovels, bulldozers, mining machines, mine cars, steel mill ladles, blast furnace draft lines, lift trucks—in high speed rotating machinery, in stamping or forging presses. It is being considered for use in tension members of cantilever bridges and other similar applications where tension members are involved.

With the 90,000 psi. minimum yield strength to work with, combined with extraordinary sub-zero toughness, good high temperature strength to 900 F., and excellent resistance to impact abuse, impact abrasion, and atmospheric corrosion, you can use T-1 steel to reduce the size and weight of heavily stressed parts. This cuts your shipping and handling costs, as well as the cost of material, and the cost of foundations and supports where they are needed. Carilloy T-1 steel lengthens the life of your equipment, cuts repair bills and outage time. And remember, wherever you use T-1, you can weld or flame cut it either in the shop or in the field without expensive heat treating equipment. This cuts costs still further.

UNITED STATES STEEL CORPORATION, PITTSBURGH
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA.
UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
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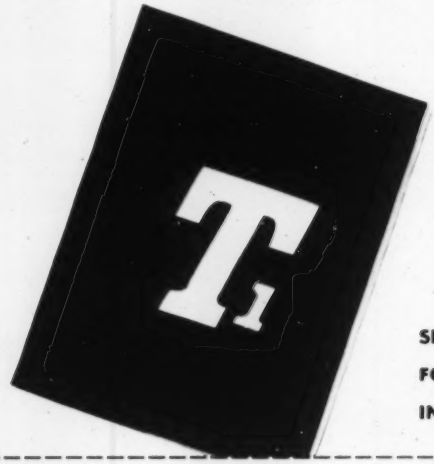

SEND COUPON FOR COMPLETE INFORMATION.

United States Steel, Room 4481
525 William Penn Place
Pittsburgh 30, Pa.

☐ Please send me your booklet "United States Steel presents T-1" which contains the full story of T-1 steel.

☐ Have your representative get in touch with me.

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USS

UNITED STATES STEEL

THESE EXCLUSIVE PRECISION-MACHINED GUIDES

eliminate chatter

lengthen service life

IN LUNKENHEIMER

IRON BODY GATE VALVES

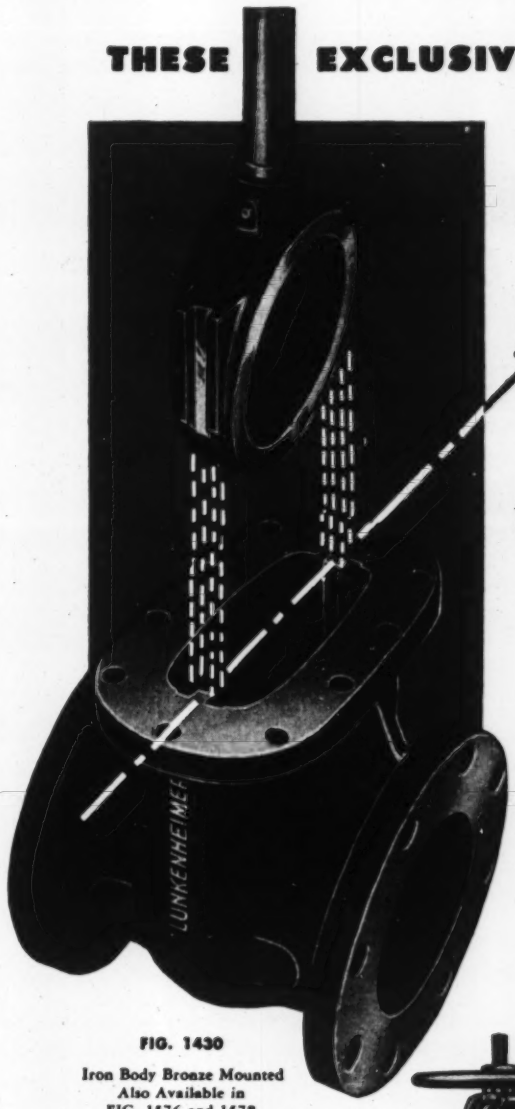

FIG. 1430

Iron Body Bronze Mounted
Also Available in
FIG. 1576 and 1578
All Iron
Screwed and Flanged Types

This exclusive machined-guide design is only one of the many original money-saving features of Lunkenheimer Iron Body Gate Valves. Gate valve chatter — the sound of wasteful, accelerated wear—is eliminated by Lunkenheimer's unique method of manufacture. Not only are the guide channels in the disc accurately machined, but the guides in the body, as well. These precision-machined guides hold the disc firmly in line as the valve is opened and closed — prevent pressure from forcing the disc against the opposite seat. Result: no clatter, no chatter, and much longer valve life. When repair is necessary, replacement parts can be easily installed without machining or fitting — an exclusive Lunkenheimer feature. In addition, Lunkenheimer Iron Body Gate Valves have long-wearing Stemalloy® Stems, bronze bushings that protect the stem from corrosion and scoring, and handy swing bolts and shelves that make repacking so easy. No other iron-body valve gives you so much *outstanding* value.

WRITE FOR Circular 564, describing the complete Lunkenheimer Iron Body Gate Valve line. Address: The Lunkenheimer Co., Box 560C, Cincinnati 14, Ohio, or phone your Lunkenheimer Distributor.

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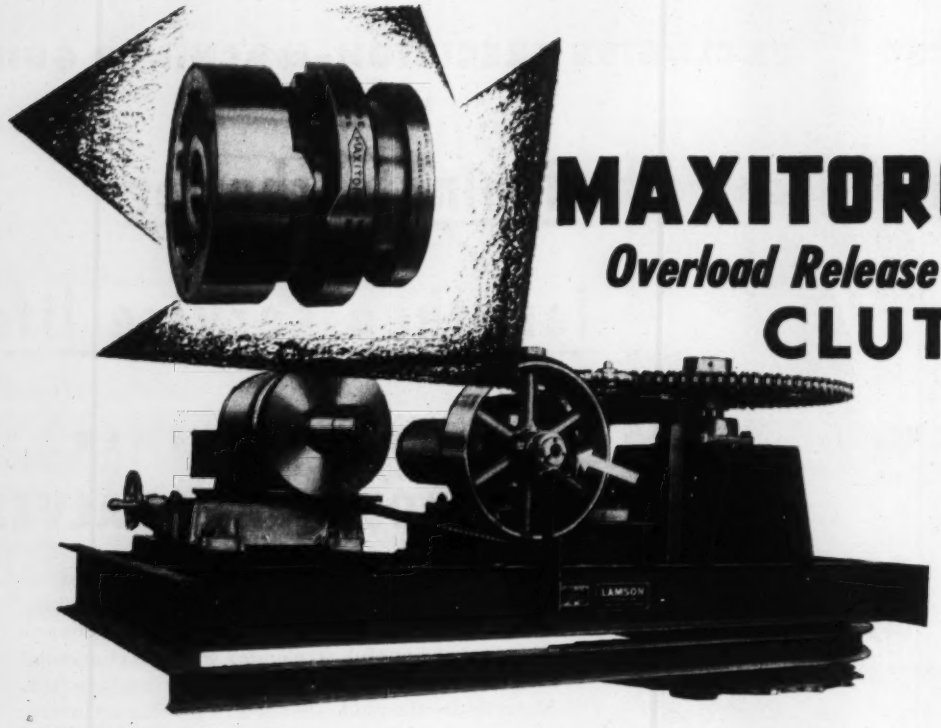


MAXITORQ
Overload Release
CLUTCH

protects against conveyor overload

FOR THE LAMSON CORPORATION

This prominent Syracuse, N. Y., manufacturer of materials handling equipment has selected the Maxitorq Overload Release Clutch for power transmission on its drive unit for the Lamson overhead conveyor. On installations which handle heavy loads the cam design feature automatically causes instant disengagement of the clutch when the overload is substantially greater than the normal driving load . . . thus preventing damage to product and machine.

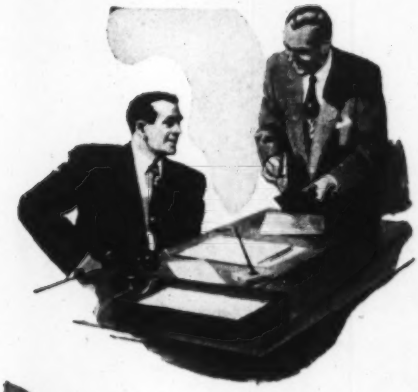
The Overload Release Clutch has all of the highly favored features of the standard Maxitorq floating disc clutch . . . Separator springs that keep discs "floating" in neutral . . . no drag, no abrasion and, consequently, no heating in neutral. Assembly, adjustment and take-apart are made without use of tools. Engagement is easily controlled, with light pressure. Disengagement is instant and complete.

There are six capacities, ¼ to 5 h.p. at 100 r.p.m. Maximum working torque from 13 to 263 ft. lbs. There are so many varied applications of this Overload Release Clutch that we suggest submitting your clutch problems to our engineering department for practical recommendations. In other words, "let's talk Maxitorq."

4 CJ 54

SEND FOR CATALOG NO. ME-9

THE CARLYLE JOHNSON MACHINE COMPANY
MANCHESTER • CONNECTICUT



SEE RUST-OLEUM APPLIED DIRECTLY OVER SOUND RUSTED SURFACES! MAKE THIS TEST UNDER YOUR OWN CONDITIONS AND SEE PROOF OF PERFORMANCE!

See Rust-Oleum 769 Damp-Proof Red Primer actually applied over a badly rusted surface after simple scraping and wire-brushing to remove rust scale and loose rust in the Rust-Oleum *"rusted panel demonstration."* Rust-Oleum's specially-processed fish oil vehicle *penetrates* rust to bare metal usually eliminating sandblasting and other costly surface preparations.

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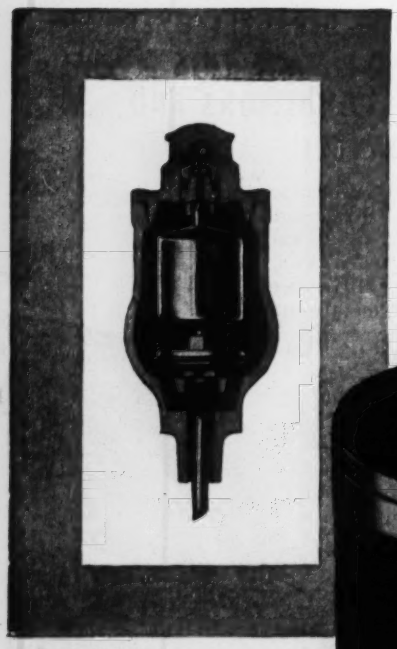

A well placed air vent can work a heating miracle!

No. 5 Rapid Vent. Float and thermostatic construction. Designed for use at the end of steam mains, tops of risers and other similar locations on vapor and one pipe vacuum systems where the maximum venting requirement does not exceed one cubic foot per minute at 5 psi.

No. 6 Quick Vent. Thermostatic only. Designed for installation at high points in the piping where there is not sufficient room for the No. 5 Vent or where a float is not needed. Same venting capacity as No. 5.

In a Wilmette Illinois Building, an outwardly well-engineered vacuum system had been a headache for years. Then, last winter, along came a heating man who quickly sized up the situation and said with real conviction: "Put a Marsh No. 5 Vent right there!"

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Unusual? Not in the least: over the years we have seen a lot of wonders worked by installing the right kind of Marsh air vent in the right spot. A number of these dependable vents are illustrated here . . . products that express an unrivaled accumulation of knowledge in dealing with air venting problems.

Marsh air vents are fully covered by the Marsh Heating Specialty Catalog along with Marsh Traps and Valves. Your local Marsh man will be glad to work with you in applying Marsh Vents effectively.

No. 50 Air Vent. Float only. Designed to remove air and gases automatically from hot or cold water tanks, coils or piping, liquid pump systems or similar applications where it is necessary to vent air rapidly. Maximum working pressure, 125 psi.

No. 55 Air Vent. Float and thermostatic construction. Is capable of expelling large volumes of air without passage of water or steam and is designed for use on steam pressure vessels or systems. Maximum working pressure, 125 psi.

No. 7 Air Eliminator. Float and thermostatic construction. Especially suitable for installation at the ends of steam mains, return piping and tops of risers where it is necessary to expel a large volume of air from the system. Suitable for working pressures up to 15 psi.

MARSH HEATING EQUIPMENT CO.
Sales Affiliate of Jas. P. Marsh Corporation
Dept. 29, Skokie, Ill.

MARSH

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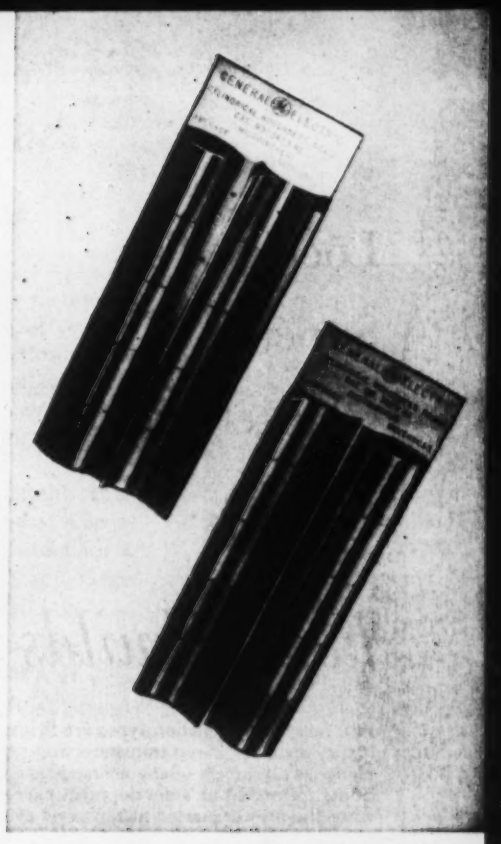
COMMON REFERENCE for designers, draftsmen, inspectors, and machinists is provided by the new G-E cylindrical roughness scales. They help to eliminate expensive "overfinishing" and rejects by quickly detecting unsatisfactory work.



COMPACT AND LIGHTWEIGHT, the complete set with case weighs 4½ oz. Dimensions of each scale: 6 in. long, 2 in. wide, ¼ in. thick.

General Electric Announces . . . .

New Surface Roughness Scales for Curved Finish Accuracy

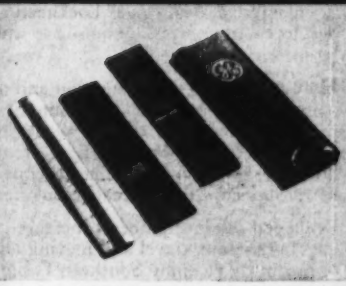
The new General Electric cylindrical roughness scales are designed to provide time- and cost-saving standards for curved, machined surfaces.

ELIMINATION OF GUESSWORK resulting in unnecessarily fine or excessively rough finishes is achieved by these versatile new scales. Offering a ready surface comparison, their application also results in less design and drafting time—and your inspectors do a quicker, more accurate job.

TWO SCALES make up the complete set. On one are surfaces with values from 4 to 63 microinches, produced most commonly by grinding, honing, and superfinishing. The second scale has surface values from 16 to 250 microinches, which are typically obtained by turning and boring operations in lathe and screw machines. Price: $31.98*.

CONTACT your nearest G-E Apparatus Sales Office, or write for Bulletin GEC-774 to Section 605-71, General Electric, Schenectady 5, N.Y.

* Manufacturer's suggested retail price.



FLAT, POCKET-SIZE scales give specifications for flat-surface machine finishes. They provide a ready portable checking tool. Price: $20.12*.

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Why the composite check

The composite check recommended in American Standard B6.11-1951 tests gears functionally by running the gear against a master of known accuracy. The resulting displacement shows at once the cumulative effect of as many as six types of error—eliminates time-consuming checks for each individual error. The check is rapid and conclusive.

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To meet today's tolerance requirements, the Kodak Conju-Gage Gear Checker uses a master made with a new order of precision. This is the Kodak Conju-Gage Worm Section, produced by thread grinding under control of a precision lead screw.

The accuracy inherent in this method means every right gear is passed by the worm section, reducing rejection losses. The transverse curvature produced by this method provides a master that can be used to check any gear of like pitch and pressure angle, regardless of helix.

Not only can a single worm section be used in place of a number of circular masters, but such a worm section can be reground to specification as often as necessary—at a fraction of replacement cost. It is easily checked for accuracy by familiar toolroom procedures.

You can find out more about the economies possible through Kodak Conju-Gage Instrumentation by sending for a copy of the booklet, "Kodak Conju-Gage Gear Testing Principle." Write to:

Special Products Sales Division
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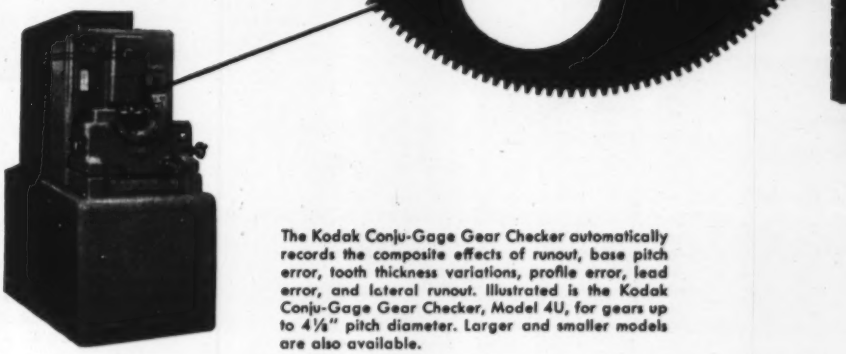
Rochester 4, N. Y.



The Kodak Conju-Gage Gear Checker automatically records the composite effects of runout, base pitch error, tooth thickness variations, profile error, lead error, and lateral runout. Illustrated is the Kodak Conju-Gage Gear Checker, Model 4U, for gears up to 4½" pitch diameter. Larger and smaller models are also available.

CONJU-GAGE INSTRUMENTATION

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To inspect all kinds of complex parts on a bright screen, Kodak also makes two highly versatile contour projectors.

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MB cycling system runs vibration tests automatically

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A vibration test that involves a continuous cycle of changes from 10 to 500 cps along with constant displacement or constant acceleration can now be done with great simplicity, accuracy and minimum supervision. Simply set up the specimen on an MB Shaker—set the controls for the desired actions—and let the cycling system take over.

This electronic unit varies shaker frequency at any sweep speed, and between any two preset frequency limits. It controls the exciter's amplitude or acceleration within ±10% for a dead mass or resonant type of loading and for cycled tests to satisfy MIL-E-5272 and other specifications.

For maximum flexibility of operation, this cycling system also provides for automatic transfer of constant amplitude to constant "g" at any preselected frequency setting.

The system can be operated manually when desired. It's also protected against control failure or conditions of extreme load resonances through use of an automatic structural strain control.

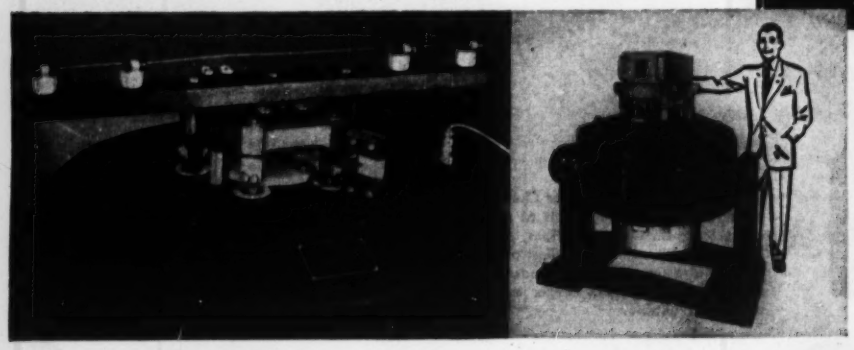
SHAKE TESTING PAYS

Vibration testing tells how well a product will bear up in service, reveals design faults, determines fatigue strength.

Designed for heavy duty service, MB vibration exciters such as the Model C-5, rated at 750 pounds force, and the Model C-25 rated at 3500 pounds force, deliver maximum performance, pure table motion and dependable operation.

Send for detailed specifications on MB cycling systems. Also for Bulletin which gives data on vibration exciters.

MB MODEL T-25 MC CONTROL CABINET with automatic cycling system developed to control the action of vibration exciters to a specified cycle of events, and with little or no supervision.

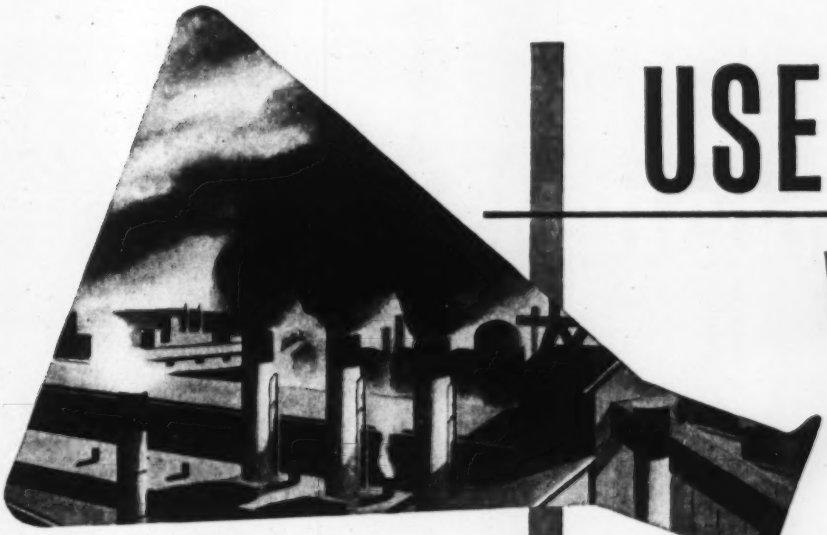


A VIBRATION TEST set up on the Model C-5 MB Vibration Exciter—and also one on Model C-25—two of the models which can be automatically controlled by MB's cycling systems.

THE MB MANUFACTURING COMPANY, INC.
1060 STATE STREET, NEW HAVEN 11, CONN.

BULLETIN TELLS MORE
Contains specifications, operating information and helpful hints on usages of the complete line of MB Exciters. Write for Bulletin 1-VE 4.

PRODUCTS AND EQUIPMENT TO CONTROL VIBRATION • TO MEASURE IT • TO GENERATE IT



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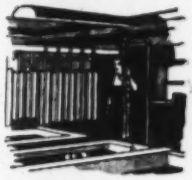
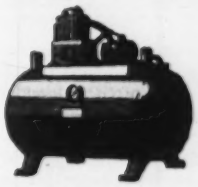
Let the adaptable Servel 25-ton Water Chiller convert waste heat, or steam from any source, into lowest cost air conditioning for your plant and offices!

PROCESS COOLING

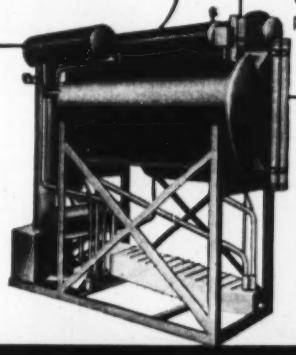


Use the cheapest energy source —even waste heat—to achieve high-efficiency cooling for manufacturing processes! Servel Water Chiller operates on dependable absorption principle.

INDUSTRIAL PRECOOLING



Increase capacity and improve performance of air compressors and internal combustion machines! The Water Chiller is compact, light; can be safely installed on almost any floor.



The Servel Water Chiller cooling system has no moving parts to wear. It is quiet and vibration-free. Light floor loading and freedom from vibration mean that no special foundations or braces are needed. Zone control is unusually easy. And operation (using waste heat, or steam from the cheapest source) is low in cost. Backed by a 5-year warranty. See your dealer or mail coupon for information and engineering co-operation.

Servel

the name to watch for great advances in

AIR CONDITIONING ✓ REFRIGERATION

SERVEL, INC., Dept. ME-94, Evansville 20, Indiana

Please send me complete information on Servel equipment for
☐ Air Conditioning, ☐ Process Cooling, ☐ Industrial Precooling.

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ZEISS Ni2
SELF-LEVELING LEVEL

This amazing new instrument cuts leveling time and costs in half. It sets a line of sight precisely level *automatically*. A remarkable new invention, the Compensator, built into the telescope levels the line of sight for you in a matter of moments. It performs any kind of leveling, from rough cross sectioning to first order work. Bench-mark leveling, using two rods, is almost twice as fast with the Ni2 as with an ordinary level. Cross-sectioning with many sights from one set-up is even faster. Accurate up to ± 0.02 ft. per mile, the Ni2 is as rugged as its appearance suggests.

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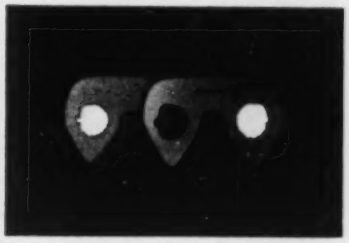
Converts from steam engines to diesel ...uses Morse Silent Chain Drives

Case-enclosed Morse Silent Chain Drive



Exclusive Morse Rocker-Joint. The only joint action is a rocking action, requiring less lubrication, and assuring extra-long service life.

The steam drives on four large dock cranes at the Pulpwood dock of Hammermill Paper Company, Erie, Pennsylvania, were converted by Great Lakes Diesel to 70-hp diesel engines with torque converters. They are used to drive 10-ton cranes which unload four-foot and eight-foot logs by chain slings from the lake steamboats.

The diesel drives use Morse Silent Chain, ¾″ pitch x 4″ wide, and include cases for the drives. The motor drive sprocket has 23 teeth, the driven sprocket 149 teeth.

Morse Silent Chain Drives transmit power smoothly and noiselessly, with over 99% efficiency. The service life of the drives is exceptionally long and trouble-free. Smooth, positive action reduces slippage losses on shaft bearings. The exclusive Morse Rocker-Joint construction converts sliding action to rolling motion. Morse Silent Chain Drives are compact, unaffected by atmospheric conditions.

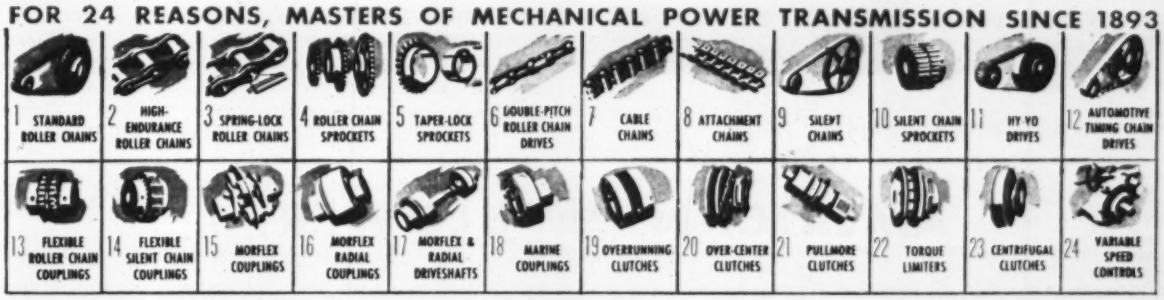
Available in pitches from 3/16″ to 2″, these drives will handle fractional horsepower or hundreds of horsepower in a single drive.

For more detailed information on how precision-built Morse Silent Chain Drives can help you in your applications, contact your local Morse distributor. Or, write:

MORSE CHAIN COMPANY
7601 CENTRAL AVENUE
DETROIT 10, MICHIGAN

MORSE BW
MECHANICAL POWER TRANSMISSION PRODUCTS

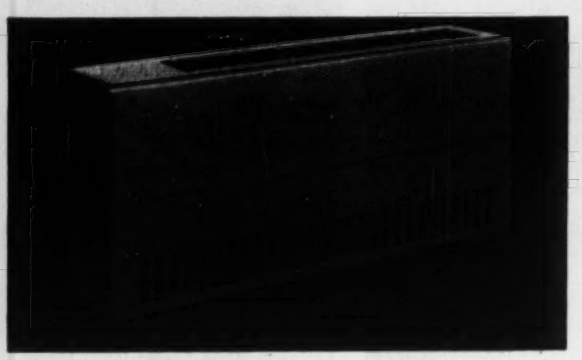
FOR 24 REASONS, MASTERS OF MECHANICAL POWER TRANSMISSION SINCE 1893



Choose the heater that fits your job best!

American Blower offers you a *complete line* of commercial and industrial unitary-type heaters for maximum flexibility in layout and design!

Equitemp Air Diffuser on new **Venturafin Vertical Unit Heaters** is adjustable, and permits an even flow of heat. It produces a cone of heated air that mixes with room air—for breathing-level temperatures that vary less than one degree! Anemostat and vane-type diffusers also available. 58,400 to 560,000 BTU at 2 psig, 60°F. entering air.



Looking for an attractive and efficient unit heater for your lobby? Office? Showroom? Corridor? Then install American Blower **De Luxe Cabinet Unit Heaters** for steam and hot-water systems! Recessed and non-recessed types for ceiling or floor installation. Finished in attractive gray-green baked enamel. Five basic sizes; permanent or disposable filters.

If you want *both* low price and top heating performance, put in American Blower's new **Venturafin Horizontal Unit Heaters!** They're truly quiet, and have separate coil systems for hot water and steam. Serpentine design of hot-water coils increases output; permits use of smaller units in many cases. Capacities: 18,000 to 357,500 BTU at 2 psig, 60°F. entering air.

You can't go wrong if you (1) plan to use gas as fuel on your next heating installation, and (2) use American Blower **Gas-Fired Unit Heaters!** They're compact and modern in design; come in both conventional and duct types, to let you tackle any size job. Use them individually or in combination; easy to install, economical to operate. Capacities: 50,000 to 230,000 BTU/hr input.

* * *

For complete data on American Blower unitary-type heaters, jot down your request on a post card and mail it to: American Blower Corporation, Detroit 32, Mich. Better yet, step into your American Blower jobber's and see them for yourself—today!

AMERICAN BLOWER CORPORATION, DETROIT 32, MICHIGAN • CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO
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Serving home and industry: AMERICAN-STANDARD • AMERICAN BLOWER • CHURCH SEATS & WALL TILE • DETROIT CONTROLS • KEWANEE BOILERS • ROSS EXCHANGERS • SUNBEAM AIR CONDITIONERS

"Take this man I'm going to see"

"Hi, Ed. Shining up for a date?"

"Sure enough, Jim. An important one, too. I'm calling on a new prospect. He's going into a new product and I'm sure he can use our fabrication facilities!"

"I thought you fellows at Wolverine only made tubing. I didn't know that you were set up to fabricate. Never thought of you as that type of source!"

"Fabrication is one of the things we specialize in, Jim. We're equipped to do just about anything to make a tubular part. Take this man I'm going to see, for example. This part he's making starts out as a sheet of copper. The way he has it figured out, it's going to take about eight separate operations to complete the part."

"But with Wolverine's Spun End Process* we can start out with a length of copper tube and in one operation we'll end up with the complete part. We do it by spinning the tube in special dies and the die gives it the desired shape. It'll give him a one-piece part—cut his costs in half."

"Say that sounds terrific. Our engineering department will be all ears when I tell them about this. I'm sure this spinning deal can help us, too."

"That's only part of it, Jim. We also do special bending, coiling, flaring, expanding, finning, swaging, piercing and drilling as well as soldering, brazing and threading. Add to this the fact that besides copper, we work in copper-base alloys, aluminum and electric-welded steel and you have a quick run-down of Wolverine's fabricating facilities."

ALL-IN-ALL IT ADDS UP TO TUBEMANSHIP. That's Wolverine's word for the type of thinking that combines tube manufacturing with fabrication. You'll find the complete story as well as a host of new ideas in Wolverine's Fabricated Parts Book. Write for your copy today. WOLVERINE TUBE, Division of Calumet & Hecla, Inc., 1483 Central Avenue, Detroit 9, Michigan.

*PATENTED PROCESS RE. 22405

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DIVISION OF CALUMET & HECLA, INC.

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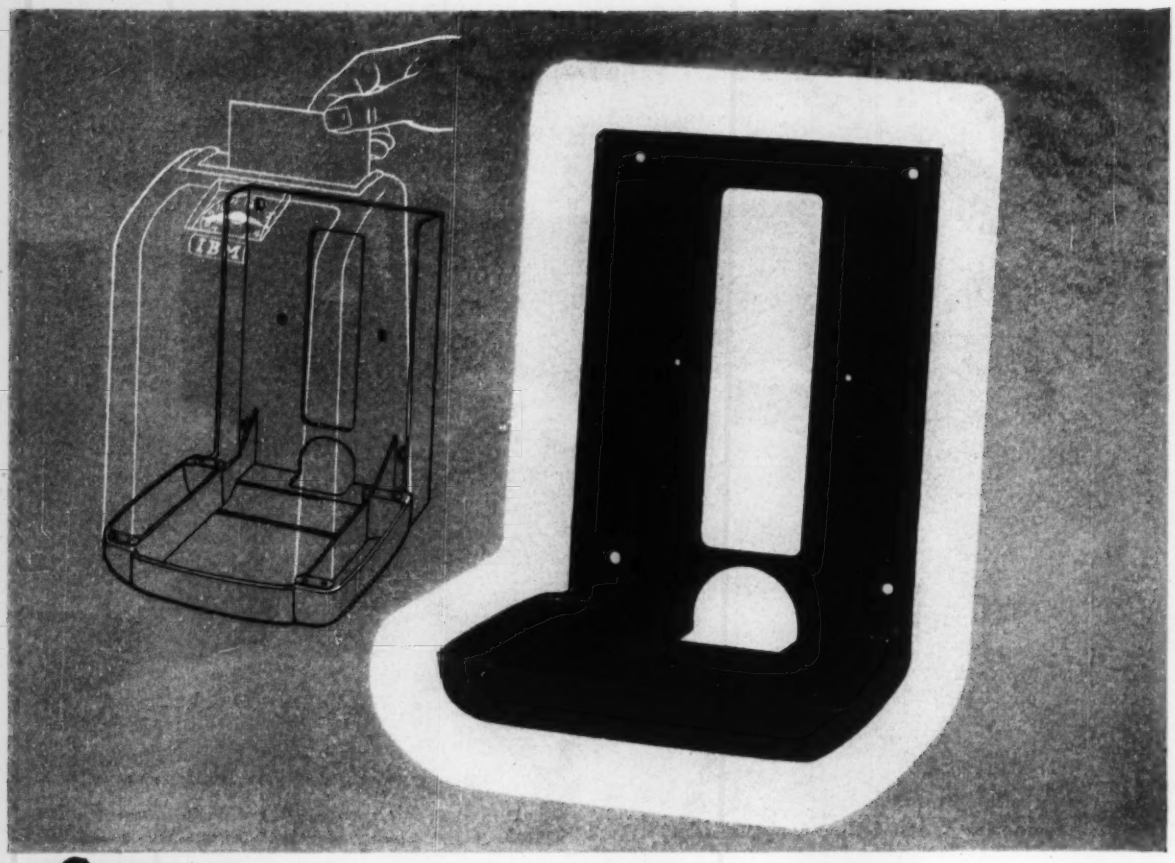

TIME MARCHES ON *automatically . . . supported by* PARKER DIE CASTINGS

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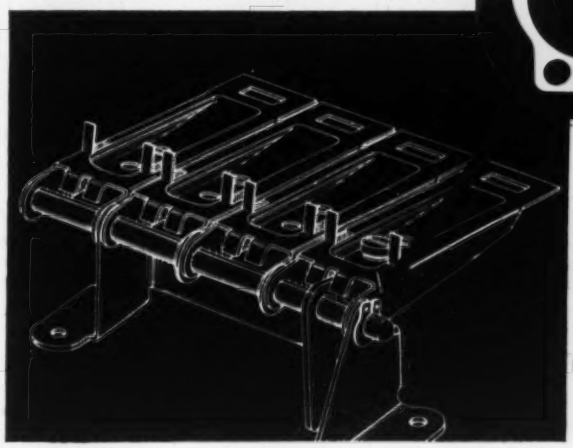
IBM's fully-automatic, electric time recorder is a far cry from the old-fashioned time clock. This modern engineering development handles with ease and sureness any kind of work schedule, no matter how complex. To produce the wall mounting bracket shown above, IBM and Parker together worked out the design of the part. The result: a die casting that meets every specification at lower total cost.

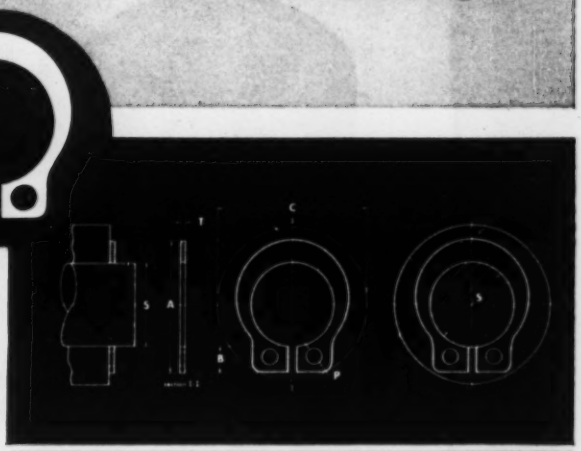
This close co-operation from blue print to finished product typifies the complete engineering—as well as manufacturing—service offered by Parker. No matter how complex your die casting problem, Parker will be glad to help you find the answer. Just call the nearest Parker sales engineer listed at the left or write the factory direct.

Parker White Metal Company • 2153 McKinley Ave., Erie, Pa.

PARKER **ALUMINUM and ZINC *die castings***

New Waldes Truarc GRIP Ring requires no groove, holds fast by friction, can be used over and over again





Ring # 5555		5555-12	5555-13½	5555-18	5555-25	5555-31	5555-37
SHAFT DIAMETER	Fract. Equiv. S	1/8"	—	3/16"	1/4"	5/16"	3/8"
	Dec. Equiv. S	.125	.136	.187	.250	.312	.375
	TOL.	±.002	±.002	±.002	±.002	±.003	±.003
RING DIMENSIONS	Thickness T	.025	.025	.035	.035	.042	.042
	TOL.	±.0015	±.0015	±.002	±.002	±.002	±.002
	Length A	.268	.285	.364	.437	.553	.626
	Lug B	.078	.078	.097	.097	.141	.141
	Hole P	.042	.042	.042	.042	.078	.078
	Min. Ring Clear C	.33	.34	.44	.50	.67	.73
Approx. Ultim. Thrust Load (Lbs)		20	20	25	35	50	60

The Waldes Truarc Grip Ring is a new, low cost fastener that provides a positioning shoulder secure against moderate thrusts or vibration. Installed on a straight ungrooved shaft, the Truarc Grip Ring can be assembled and disassembled in either direction with Truarc pliers.

The Grip Ring can be installed tightly against a machine part in order to take up end-play. The basic Truarc design principle assuring complete circularity around periphery of the shaft and the ring's unusually large radial width combine to exert considerable frictional hold against axial displacement. The ring can be used again and again.

Find out what Waldes Truarc Retaining Rings can do for you. Send us your drawings. Waldes Truarc engineers will give your problems individual attention without obligation.

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WALDES

TRUARC

REG. U. S. PAT. OFF.

RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

WALDES TRUARC RETAINING RINGS AND PLIERS ARE PROTECTED BY ONE OR MORE OF THE FOLLOWING U. S. PATENTS: 2,382,947; 2,382,948; 2,416,052; 2,420,021; 2,420,341; 2,439,785; 2,441,046; 2,455,169; 2,483,380; 2,483,383; 2,487,002; 2,487,903; 2,491,304; 2,509,091 AND OTHER PATENTS PENDING.

ME 096

Waldes Kohinoor, Inc.,
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☐ Please send me sample Grip-Rings (please specify shaft size _____)

☐ Please send me the complete Waldes Truarc catalog.

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Metal—Natural Rubber—Silicone—Neoprene—Buna S—Buna N—and others are selected by LORD Engineers to satisfy your specific environmental conditions and assure the most economical solution of your vibration control problem.

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Over 27,000 basic designs and their variations are already available from which to choose.

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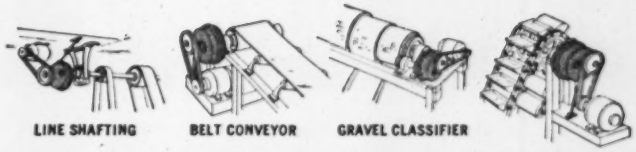
Falk ALL-STEEL Shaft Mounted Drives



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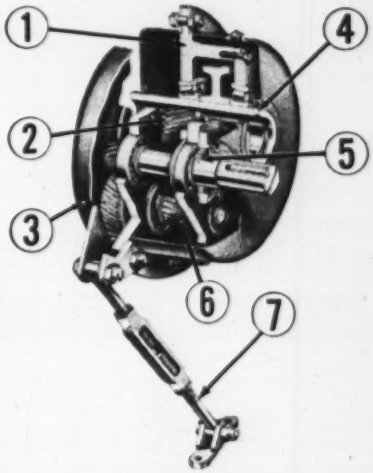
APPLICATIONS UNLIMITED

The range of applications to which the all-steel Falk Shaft Mounted Drive is ideally suited is so wide that complete listing is impracticable. The sketches above are included only to indicate a few typical installations where considerable speed reduction in limited space is an important advantage.

SIX SIZES

- 1/2 to 30 hp
- Single or double reduction
- Wide output speed range—420 to 10 rpm



These versatile, NEW speed-reducing units

save space, power, material and time

Here is the economical solution to the countless application problems requiring efficient speed reduction in limited space! The new Falk all-steel Shaft Mounted Drive—a modification of the universally-accepted Falk Motoreducer design—embodies many exclusive structural and functional features which add up to better service, longer life and substantial savings.

This rugged, compact drive mounts directly on the driven shaft—a distinct saving in floor space. Its precision Falk helical gearing gives highest mechanical efficiency, with a resultant power saving. No adjustable motor bases or slide rails are required. Installation is simple and rapid—output speeds can be quickly changed; thus time is saved...Write to Department 247 for engineering bulletin, including selection and dimension details.

FALK "In-Built" Factors... that give maximum efficiency, convenience and dependability

1 **All-steel Frame,** with more than double the rigidity of iron, supports all rotating elements.

2 **Precision Helical Gears,** designed and machined by Falk, rated to AGMA standards.

3 **Pressed Steel Housings,** whose sole function is to keep oil in, dirt out; easily removed for gear inspection without dismounting unit.

4 **Through Hollow Shaft** with counter bore provides for easiest installation or removal from driven machine shaft extensions.

5 **Backstop** can be furnished with the unit or added later for positive prevention of reverse rotation.

6 **Positive Lubrication,** continuous direct dip of revolving elements at all speeds.

7 **Tie Rod** and turnbuckle serve as anchor and facilitate V-belt or chain adjustment.

THE FALK CORPORATION, Milwaukee 8, Wisconsin

MANUFACTURERS OF

- Motoreducers
- Speed Reducers
- Flexible Couplings
- Shaft Mounted Drives
- High Speed Drives
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- Single Helical Gears
- Herringbone Gears
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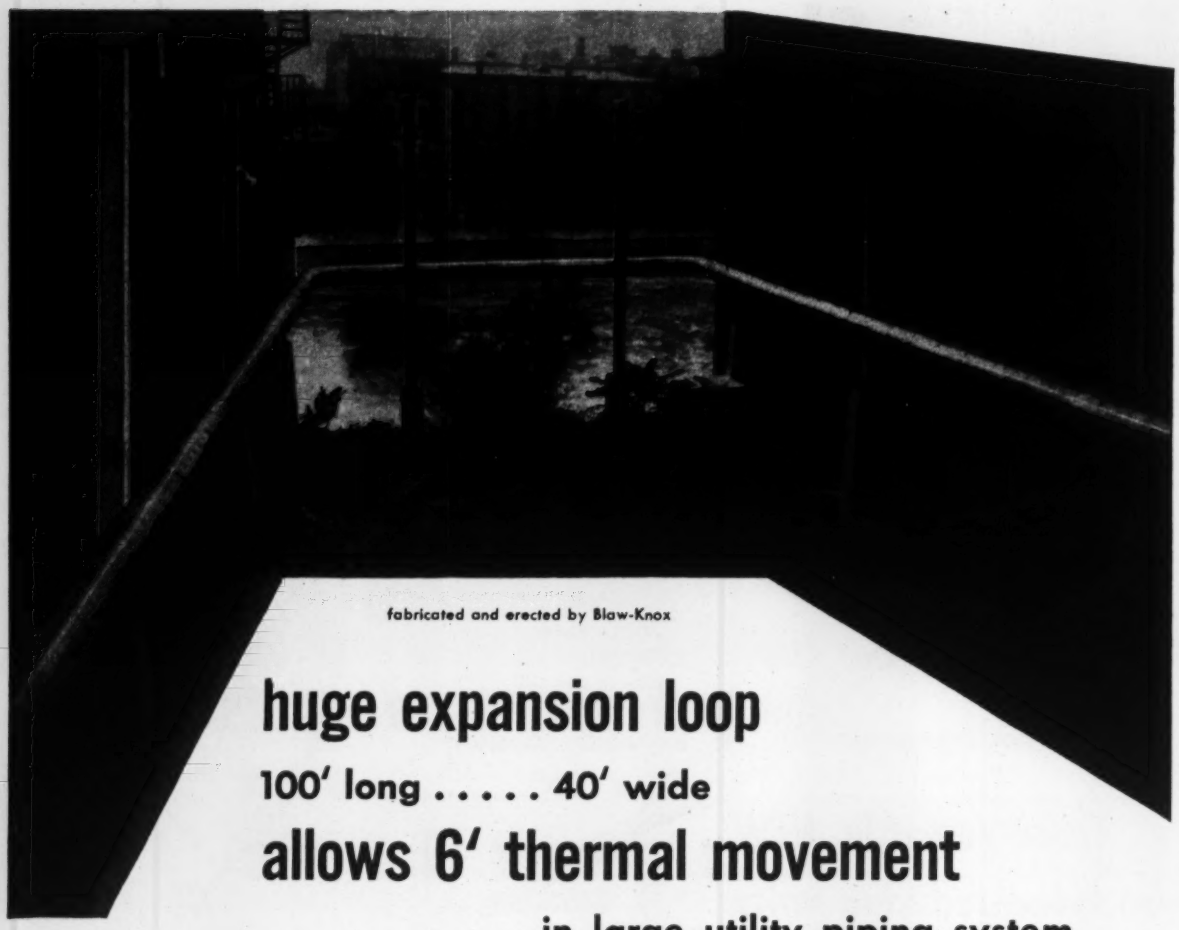
FALK

...a good name in industry



fabricated and erected by Blaw-Knox

huge expansion loop

100′ long . . . . . 40′ wide

allows 6′ thermal movement

. . . in large utility piping system

This tremendous expansion loop is only one part of a ten-inch power piping line which carries steam at 650# pressure and 750° Fahrenheit for nearly a mile throughout the downtown area of a large city. All bends were fabricated in our shops . . . and installed in the field by our service force, using Blaw-Knox functional hangers and vibration eliminators.

An unusual job . . . and you'll probably never need one just like it. But it points up the kind of service we offer you. For we have the experience and the facilities to handle any type of piping problem.

On a job you place with us, you'll have the benefits of modern shop facilities for hot and cold bending, welding and fabricating all types of piping. A metallurgical research laboratory to assure you of the latest developments in high pressure, high temperature piping. Newest types of testing equipment to insure the soundness and strength of the piping under the most severe operating conditions.

And in addition, a complete service force equipped with modern machinery for field erection . . . and the necessary manpower to handle any size job.

What's your power piping problem?

We are prepared to (1) engineer, fabricate and erect your job . . . (2) simply fabricate and erect . . . or (3) fabricate only.

Our engineers will quote from your drawings . . . or, where desired, make a field study of your piping requirements before quoting.

Write us your requirements . . . and we'll provide the service you need.

To get more information on piping for industry write for your copy of Bulletin No. 2443.

BLAW-KNOX COMPANY

Power Piping and Sprinkler Division

Pittsburgh 33, Pennsylvania

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Complete prefabricated power piping systems for all pressures and temperatures . . . plus complete line of functional spring hangers • rigid hanger assemblies • overhead roller assemblies • supports • vibration eliminators

Gas-Turbine-Powered Pump on Test at Navy Fire Fighting School

Where Hyatts turn at 40,000 rpm!

Old in theory, gas turbines are comparatively new as a practical power source. So it was big news in engine development when Solar Aircraft Company, of California, announced the world's first portable, hand-started gas turbine power plant.

Developing 50 horsepower, the new lightweight operates at the high speed of 40,000 rpm—or twenty times the speed of most automobile engines! And that's where *we* come in.

To be sure of complete bearing dependability for such high-speed operation, Solar turned to Hyatt . . . and there's a Hyatt Hy-Load Roller Bearing at the most critical position on the turbine shaft.

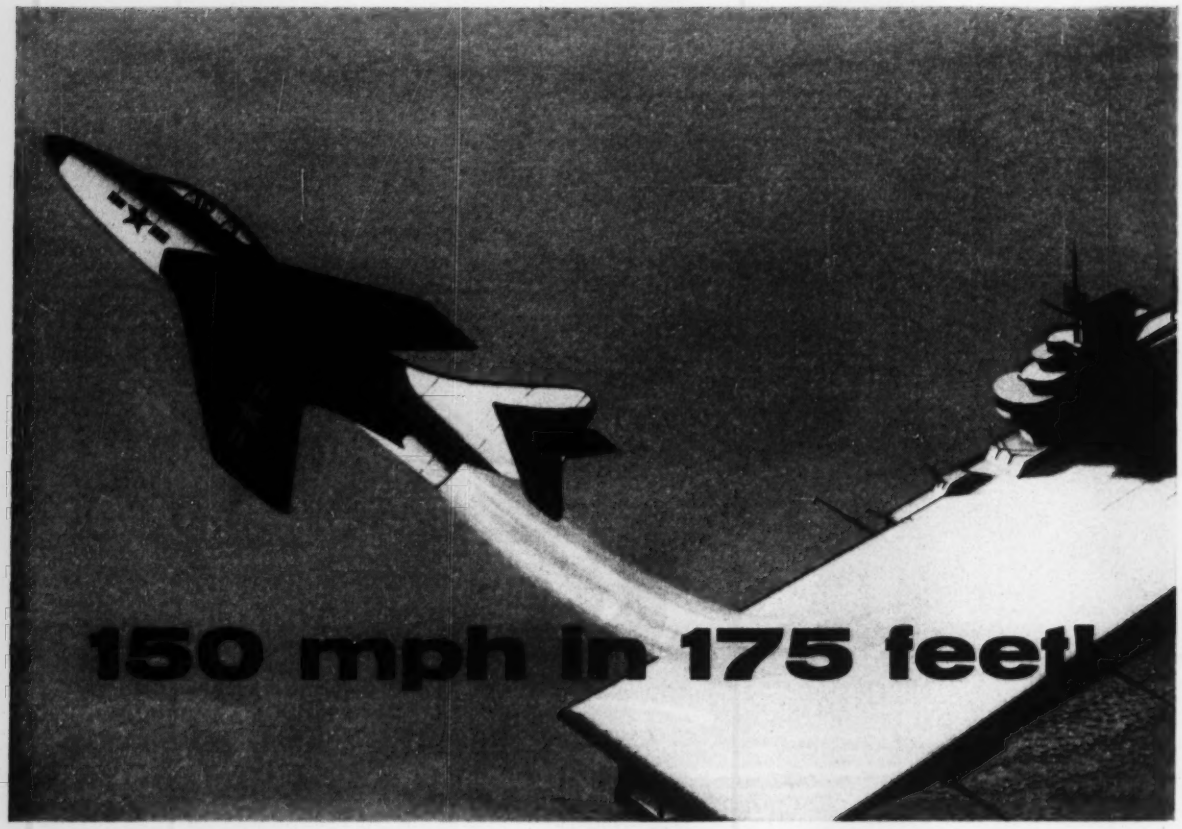
Whether you're building locomotives or lawn mowers, and whether shafts turn at 4 or 40,000 rpm, you'll get better bearing performance from *Hyatts!*

HYATT

STRAIGHT BARREL TAPER

ROLLER BEARINGS

HYATT BEARINGS DIVISION • GENERAL MOTORS CORPORATION • HARRISON, NEW JERSEY



That is the speed at which the latest steam catapult launches a jet fighter. Such speed requires precision and split-second action to control the temperature and pressure of the steam which drives the catapult. Hagan Automatic Control has been chosen for this important function.

This is just one of the many specialized applications for which versatile Hagan control systems are ideally suited. A few recent applications of Hagan Automatic Control to aeronautical and automotive test facilities are listed below.

- Automatic control systems for subsonic and supersonic wind tunnels.
- Automatic control systems for accessory and component test facilities.
- Automatic control systems for steady state, blowdown and trajectory tests in turbojet, turboprop and ram jet test facilities.
- Automatic control systems for burner stands.
- Automatic control systems for parallel and/or series operation of blowers and exhausters.
- Programmed control systems for simulated flight conditions and trajectory tests.
- Automatic controls for gas turbines.
- Automatic control of pressure, pressure ratio, temperature and mass flow.
- Direct reading mass flow meters for both air and fuel, with automatic correction for variable pressure, temperature and density.
- Automatic resolution of multiple wide range correction factors into a single correcting signal.
- Measurement and control of gas flow, with automatic correction for pressure and temperature variation.
- Jet engine and rocket thrust measurement.
- Portable thrust stands for aircraft thrust measurement.

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HAGAN BUILDING, PITTSBURGH 30, PENNA.

AERONAUTICAL AND SPECIAL PRODUCTS DIVISION

HAGAN HALL BUROMIN CALGON

Just name the valve needed--
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You'll find just the valve you need in the complete line of Powell Valves. For Powell probably makes more kinds of valves—and has solved more valve problems—than any other organization in the world.

And Powell Valves have a record of dependable flow control since 1846.

Powell Valves are made ⅛" to 30" and 125 pounds to 2500 pounds W.S.P. Bronze, iron, steel and corrosion resistant alloys. Available through distributors in principal cities. On problems, write direct to The Wm. Powell Company, Cincinnati 22, Ohio.

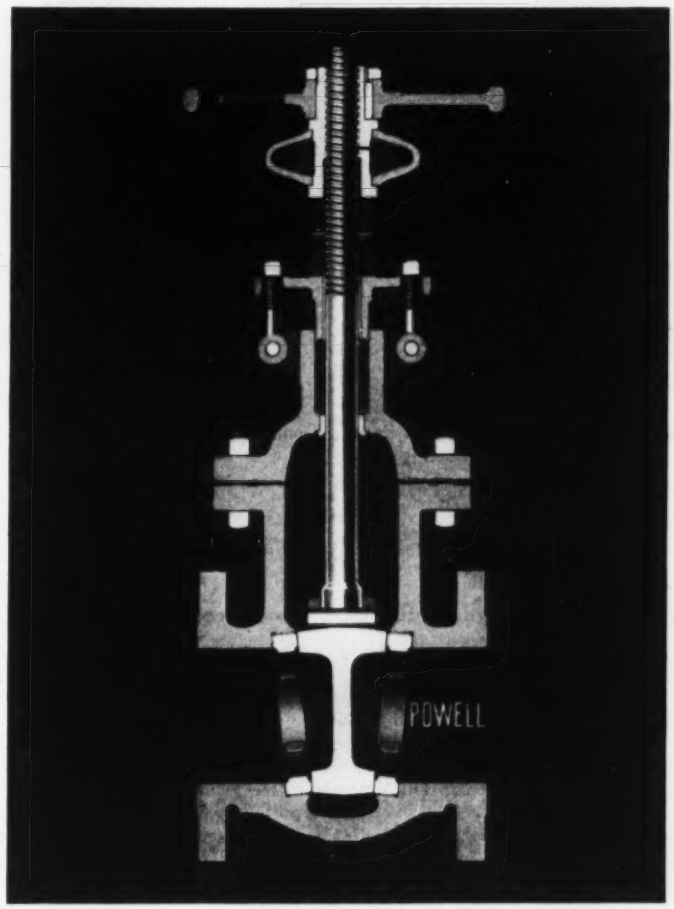


FIG. 1503 (*sectional*) **—150-POUND CAST STEEL GATE VALVE.** Flanged ends, bolted flanged bonnet with outside screw rising stem and yoke. Solid wedge. Available in sizes 1" to 24", inclusive.

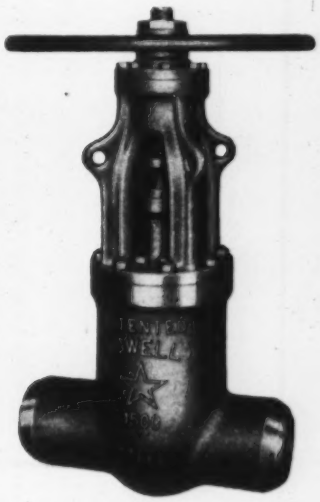
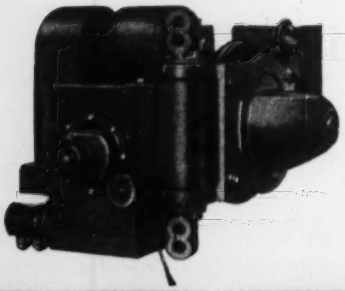


FIG. 11303—1500-POUND PRESSURE SEAL CAST STEEL GATE VALVE. Many proven advantages and exclusive features. Pressure Seal Valves are also available in Non-Return, Check, Globe and Angle Patterns for 600, 900, 1500, 2500 pounds.

FIG. 1331-A—1500-POUND INTEGRAL BONNET OFFSET GLOBE VALVE. One-piece construction eliminates possibility of leakage between body and bonnet. Sizes ½" to 2", inclusive.

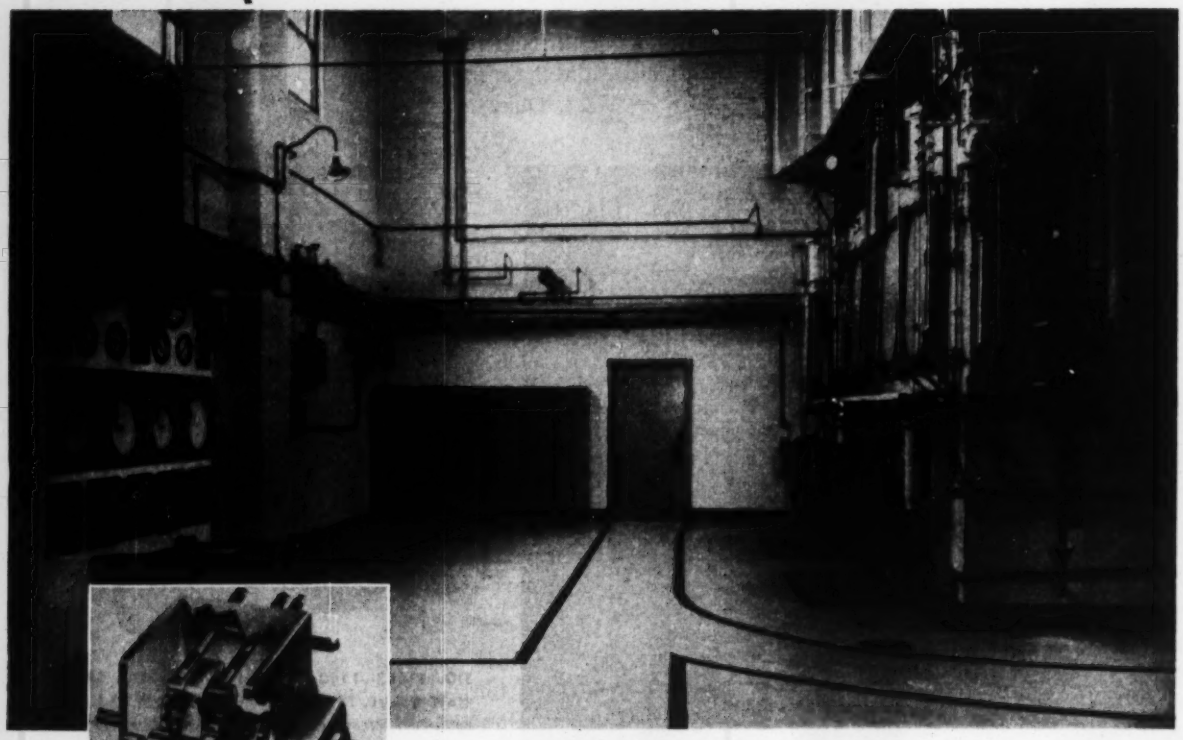
CONTROLS FOR THE LIFE LINES OF INDUSTRY

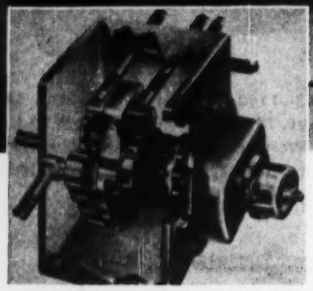
Powell Valves *108th year*



Saving: $3500 a year

with Iron Fireman Rotary Oil Burners firing No. 6 oil





Fires any weight of oil without special adjustment

The Iron Fireman Oil Volumeter is a variable volume metering pump submerged in the oil reservoir. Oil feed rate is controlled with extreme accuracy (within ½ of 1% of setting) regardless of changes in oil viscosity. Oil is measured by volume, not by valves or ports.

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This fine boiler room is 100% automatic. Full modulating fire control provides the exact volume of steam required to meet the varied demands of a fluctuating load. No slow pick-up or wasteful over-firing. Sluggish heavy oils (No. 6) are regulated with extreme accuracy by the Iron Fireman Oil Volumeter (see picture at left).

Actual cash savings of $3500 have been reported by Mr. George Juppe, Chief Engineer. About $500 of this sum is attributed to savings in maintenance costs—an indication of Iron Fireman dependability.

"Our burners have proved very reliable over a wide range of operation," says Mr. Juppe. "Their high efficiency is not affected by variance in the quality and temperature of the fuel oil."

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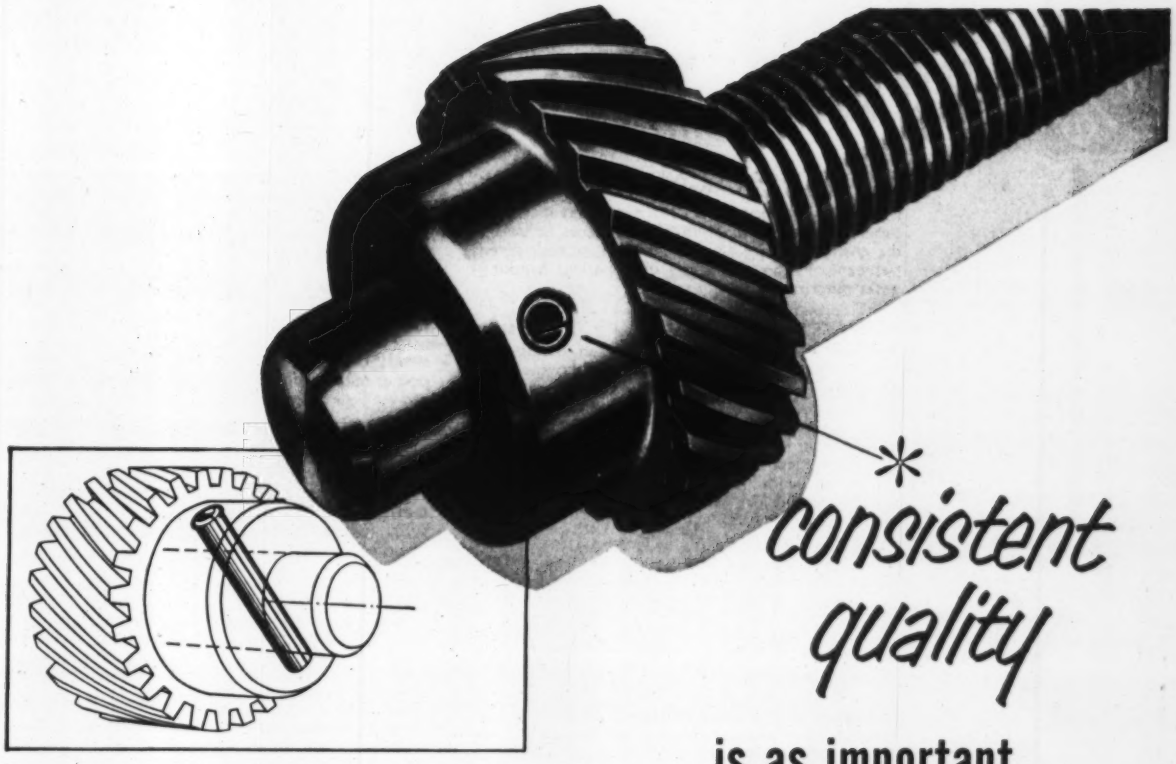
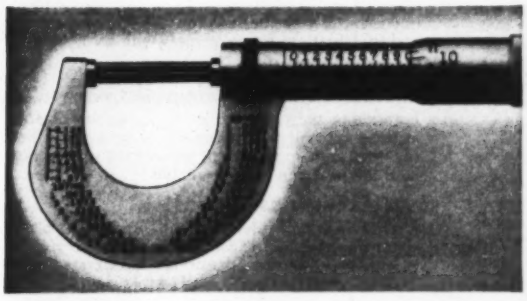


consistent quality

is as important in the pin as in the gear

To function effectively, a spring pin must drive easily into holes drilled to normal production tolerances, compressing as driven. To drive easily, hold firmly and fit flush, the pin —*every* pin—must meet the strict requirements of specifications such as those prepared by the SAE and the Military Services.



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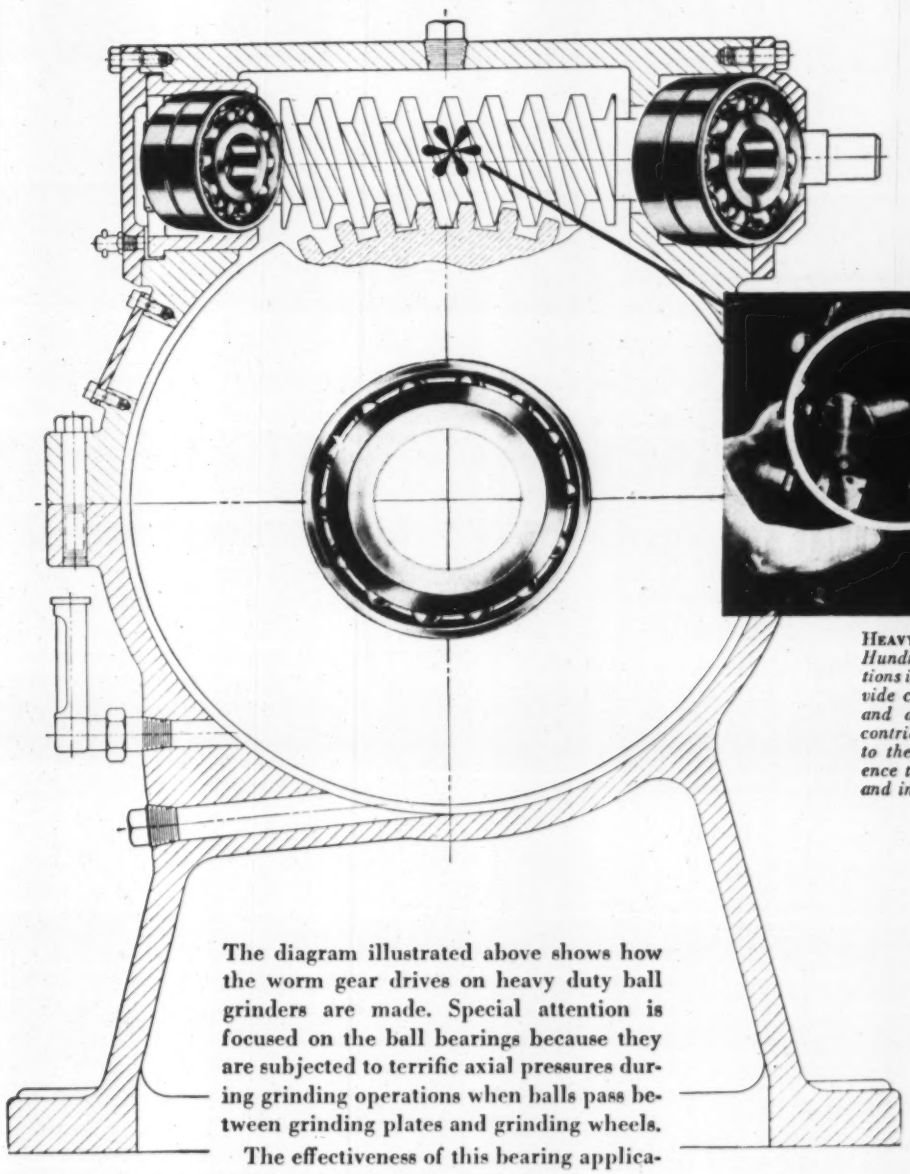

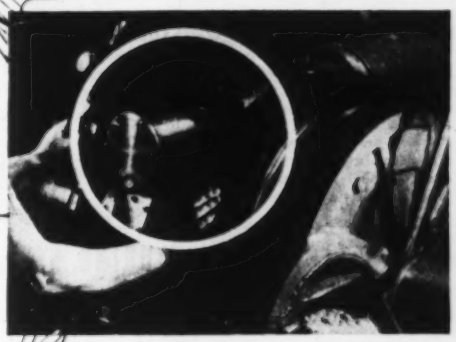

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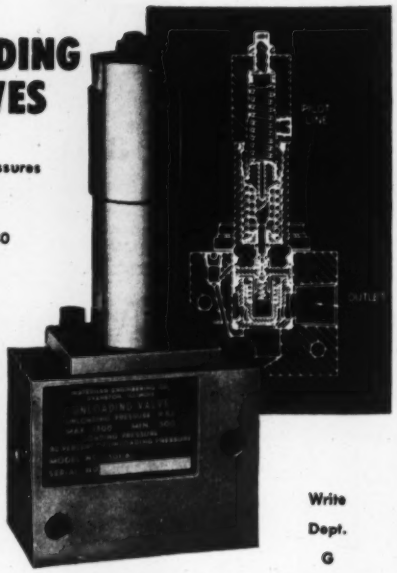

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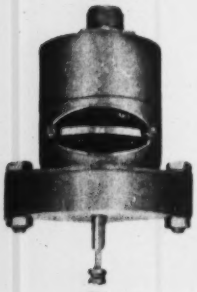

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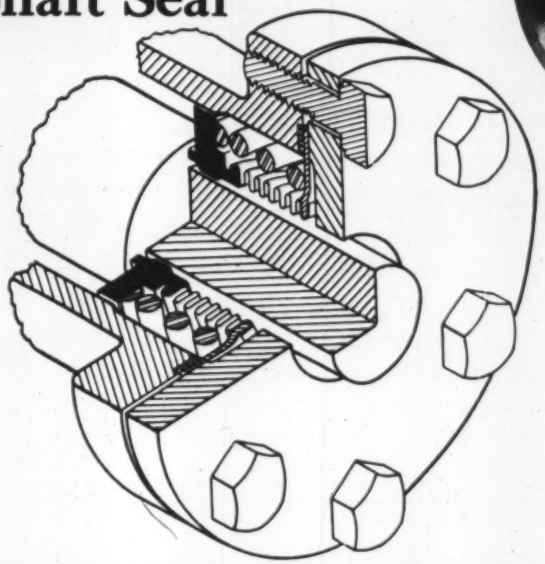
How To Design A Bellows Type Shaft Seal



BELLOWS SHAFT SEAL ASSEMBLY is mechanically attached and sealed to shaft housing on one end. Seal nose at other end bears against shoulder on rotating shaft. The bearing surface of seal nose can be superfinished. Thrust is maintained by spring-action of the bellows, backed up by loading spring and remains constant regardless of pressure changes. Result: power output of shaft does not vary with pressure changes within the system. Wear occurs at an even, low rate. No tightening or take-up is required for the life of the seal.

Advantages of Bellows Seals

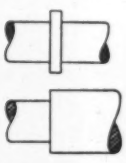
Pressure Problems Metallic bellows shaft seals have a long history of successful application in sealing shafts operating under fluid pressure conditions. A common example is their use in sealing the pump shafts of high pressure refrigeration systems.

By designing the seal nose and bellows to have equal effective areas, the thrust of the seal against the shaft face will remain constant and at a low value. Changes in internal or external pressures have no effect on the power output of the shaft and a tight seal is maintained.

Temperature Applications The all-metallic construction of bellows shaft seals make them effective over wide temperature ranges. In aircraft applications, bellows type seals operate under temperature extremes of —20F to 165F in pump shaft service. Even greater temperature ranges than these pose no problems for bellows shaft seals since they are not subject to deterioration due to heat and cold.

Shock, Vibration, Misalignment problems are frequently overcome by these seals because the bellows are inherently flexible and when a back up spring is incorporated in the design, they are ideal for such heavy duty applications as sealing torque converter shafts on trucks, military tanks and other large equipment operating under severe load conditions.

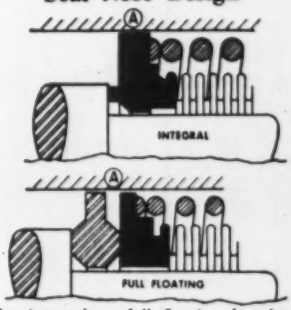
Corrosion Bellows shaft seals made of corrosion resistant metals such as stainless steels, monel, etc., greatly minimize corrosion problems. Several major manufacturers use them for sealing the shafts of gasoline and fuel pumps.



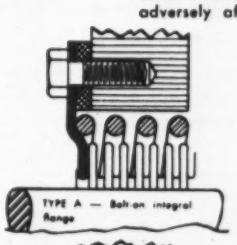
Shaft Preparation

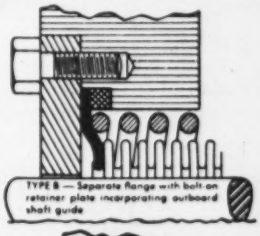
The shaft to be sealed may either be turned down to provide a face for the seal nose to bear against, or a built-up ring may be provided. In either case the shaft face should be suitably finished for the intended service. (7.4.12)

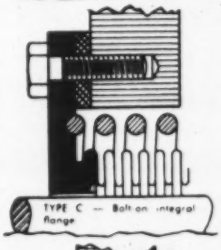
Seal Nose Design

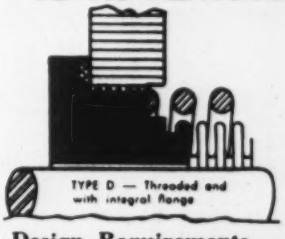


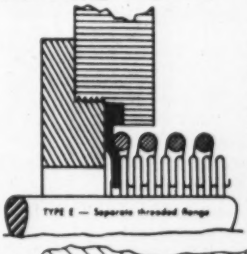
Seal nose can be integral or full floating but in either case guide the nose piece from the stationary member (shaft housing) as shown at (A). Full-floating design is best. It is poor practice to guide seal nose from shaft since vibration will be transmitted to bellows and life and efficiency of seal will be adversely affected.





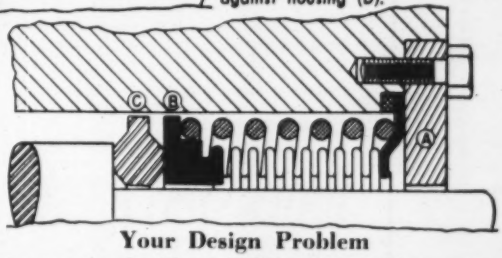






Design Requirements

The outboard end of the shaft seal must always be fastened rigidly to the stationary shaft housing and gasketed leak tight. Bellows should never be allowed to rotate with the shaft. Composite of good practice (below) shows use of an outboard shaft guide (A), nose piece guided against stationary housing (B) and use of full floating seal nose — also guided against housing (D).



Your Design Problem

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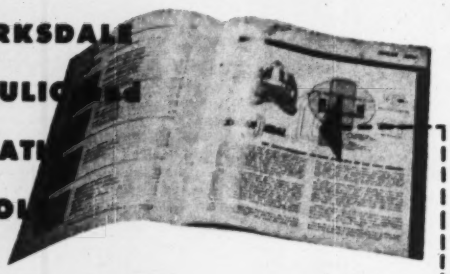
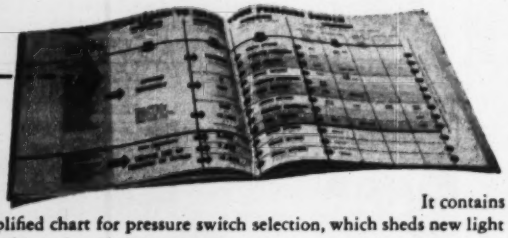


It includes important general information such as a detailed description and illustration of the Shear-Seal principle, the only new valving principle in centuries; covers manual and solenoid valves.



It contains a simplified chart for pressure switch selection, which sheds new light on a subject shrouded in mystery.

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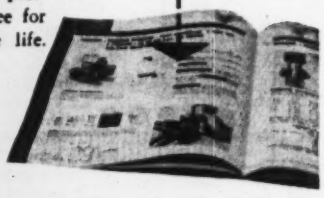

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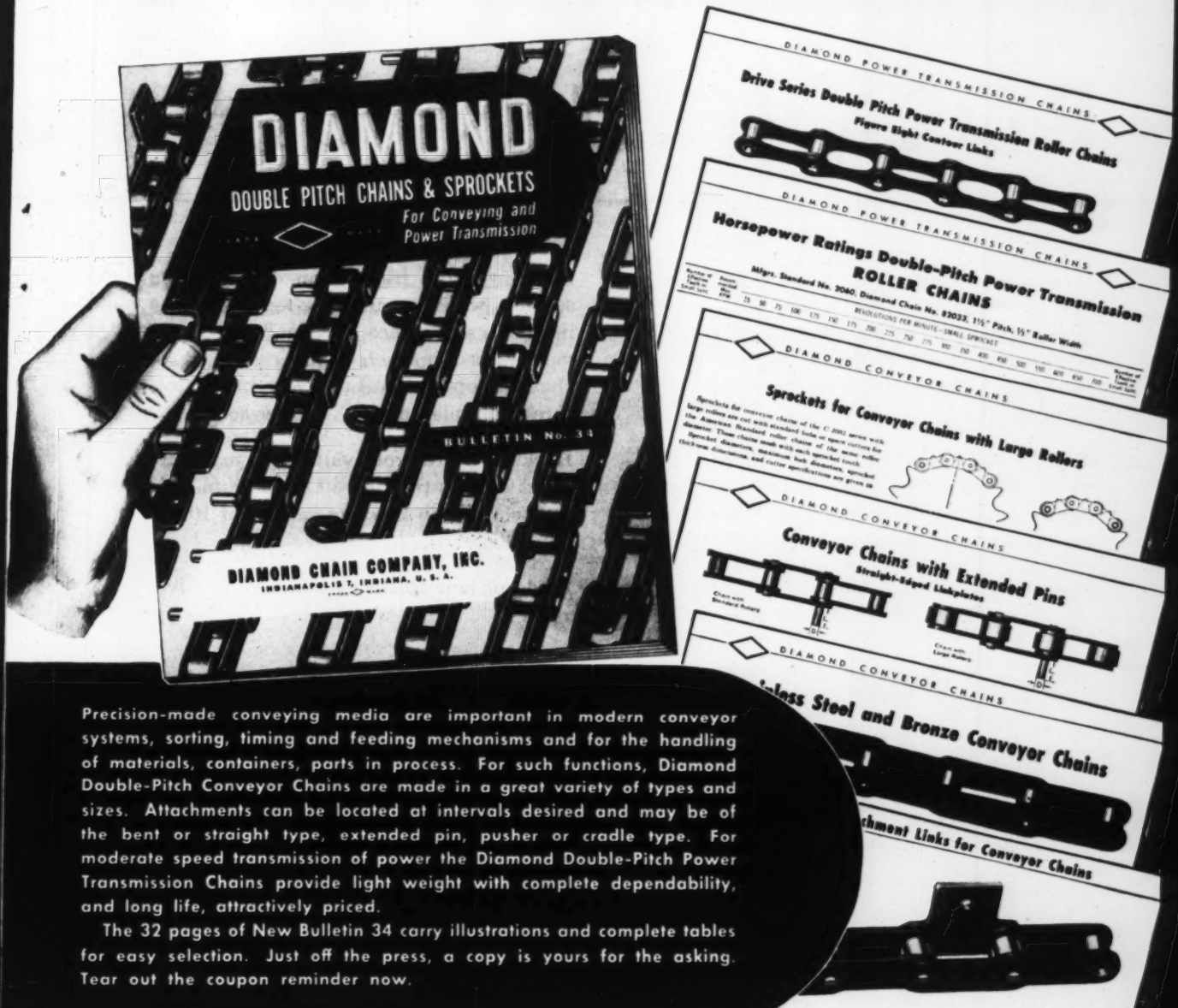
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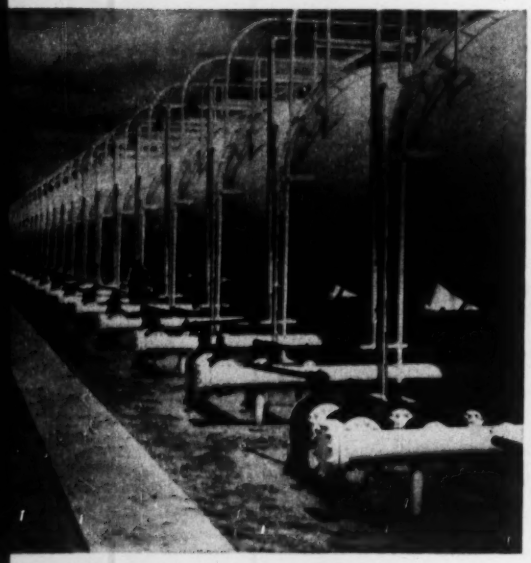
Rockwell-Nordstrom valves are manufactured in sizes through 30 in. Certain sizes are available in pressure ratings of 10,000 lb WOG.

Find out how Rockwell-Nordstrom valves

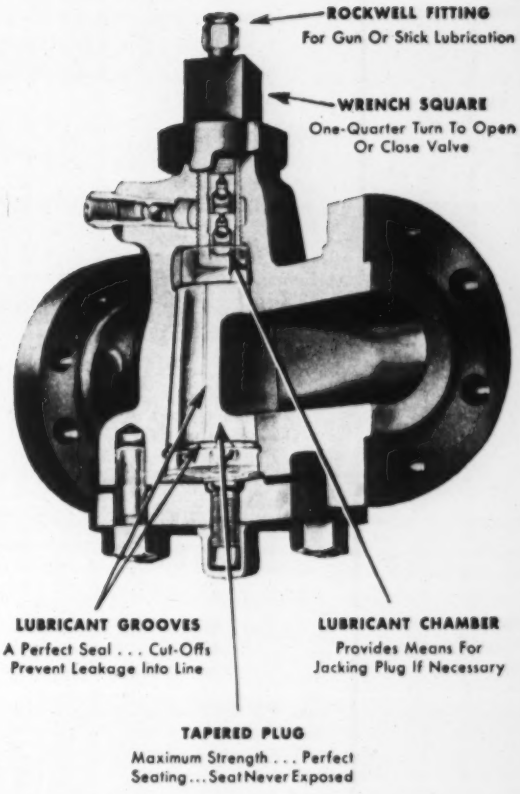


BUTANE STORAGE The Rockwell-Nordstrom valves on these butane storage tanks provide "no leak" service whether operated once a month or once every hour. Valve wrenches tell at a glance if the valve is open or closed.

FRACTIONATING These Rockwell-Nordstrom plug valves on a light ends fractionating unit can really be depended upon to do the job. Pressure lubrication keeps them ready for instant operation.

To Light Ends

VALVES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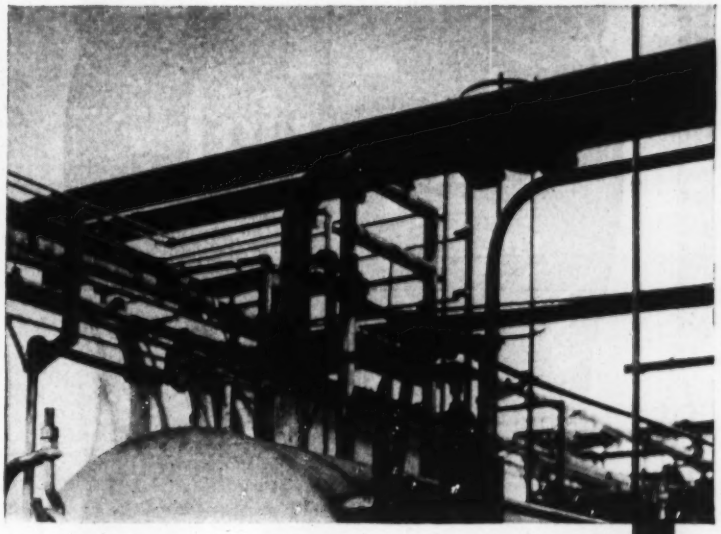
WRENCH SQUARE
One-Quarter Turn To Open Or Close Valve
LUBRICANT GROOVES
A Perfect Seal . . . Cut-Offs Prevent Leakage Into Line
LUBRICANT CHAMBER
Provides Means For Jacking Plug If Necessary
TAPERED PLUG
Maximum Strength . . . Perfect Seating . . . Seat Never Exposed

can give you better service, greater efficiency, and lower operating cost than any other valve you've ever used. Write today to Rockwell Manufacturing Company, Pittsburgh 8, Pa. *Canadian Valve Licensee:* Peacock Brothers Limited

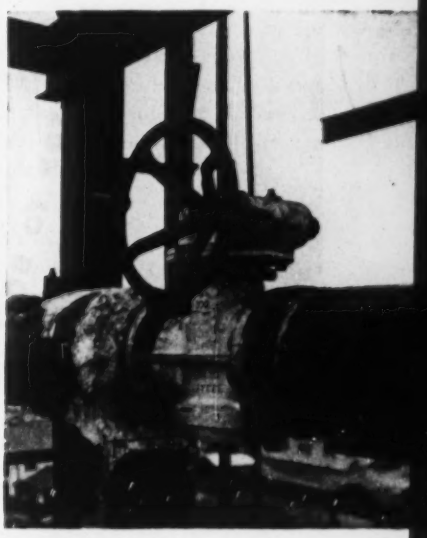
ROCKWELL-Nordstrom VALVES

Lubricant-Sealed for Positive Shut-Off

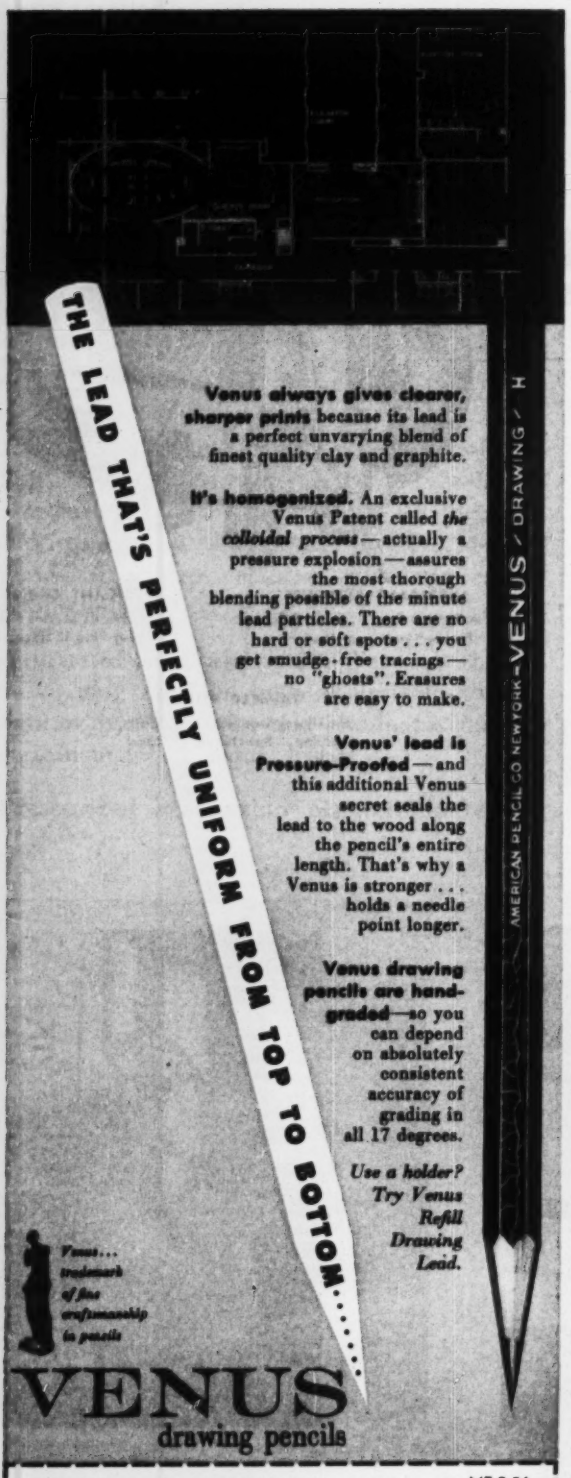
ANOTHER PRODUCT



ALKYLATION UNIT Rockwell-Nordstrom valves handle *both* the light ends and the sulphuric acid in an alkylation unit.



POLYMERIZATION UNITS For really tough service this 6 in. hard faced Hypreseal is *the* valve. Used here on the process header manifold to the inlet of catalyst tower on a polymerization unit, this valve will give long-life, trouble-free service.



Venus always gives clearer, sharper prints because its lead is a perfect unvarying blend of finest quality clay and graphite.

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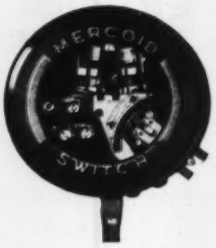
AVAILABLE IN 17 PRESSURE RANGES FROM

0-30" VAC. TO 300-2500 PSI.

WITH THE SENSITIVITY YOUR APPLICATION REQUIRES



Mercoid DA-400 Series Pressure Controls are dual purpose controls, incorporating a single pressure element operating two separate, independently adjustable Mercoid magnetic switches. The switches may be used for multiple circuit control for various operations as the control responds to pressure changes.

AVAILABLE FOR FOLLOWING OPERATIONS:

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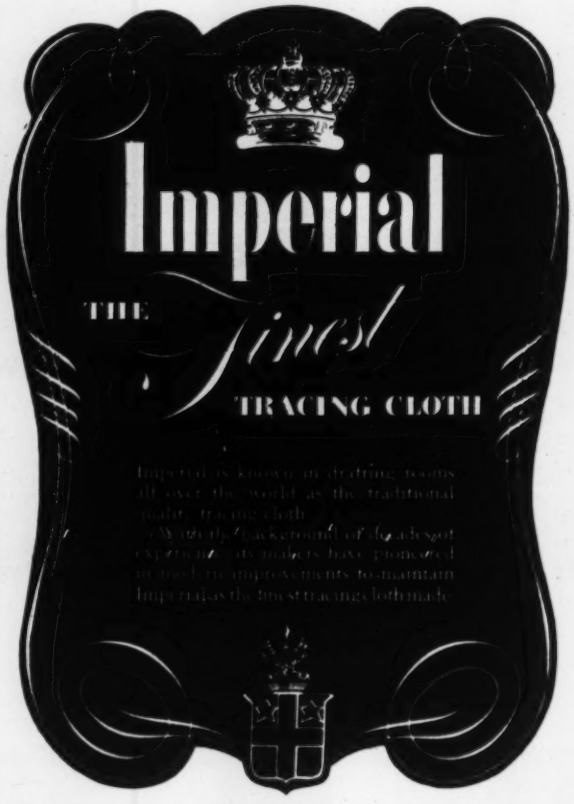
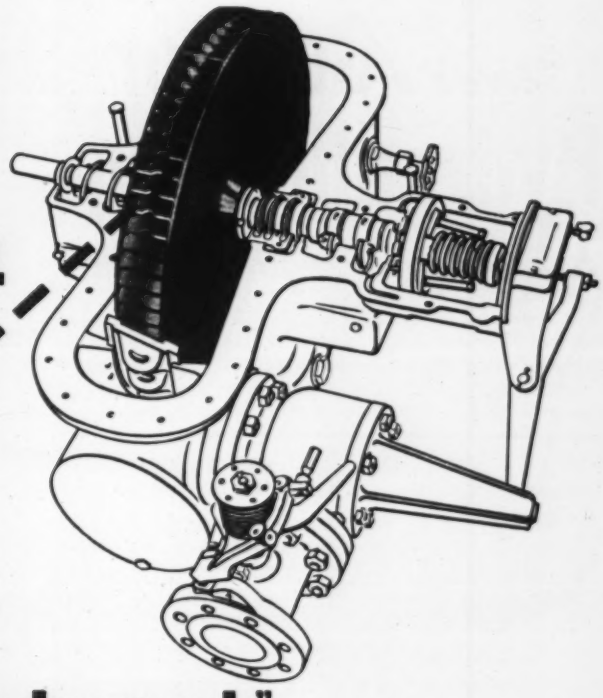
SPECIFICATION No. 4123. Both circuits close at intermediate pressure. One circuit opens on increase of pressure above neutral zone—second circuit opens on decrease in pressure below neutral zone.

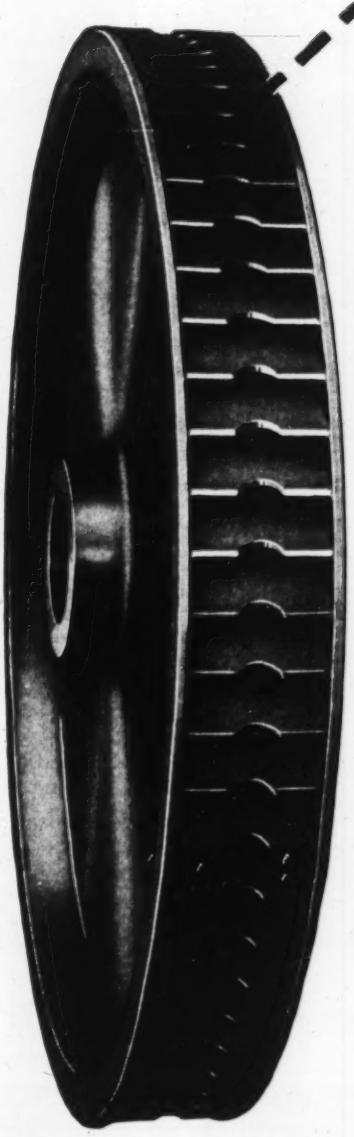
WRITE FOR BULLETIN NO. 92.

THE MERCOID CORPORATION
4201 BELMONT AVE., CHICAGO 41, ILLINOIS, U.S.A.



TERRY SOLID WHEEL





..."trade mark" of a trouble-free turbine

This is the rotor of a Terry solid-wheel turbine. There are a number of reasons why it has become a symbol for reliable, trouble-free operation.

First, because the wheel is a single forging, in which a series of semi-circular buckets is milled, there are no separate parts to become loose or work out.

Second, because the power-producing action of the steam takes place on the curved surfaces at the back of the buckets, blade wear is of little consequence. Wear does not materially affect horsepower or efficiency.

Third, because the steam enters the buckets in a direction at right angles to the shaft, there is no need for close axial blade clearances. The blades cannot foul. There is a one inch clearance on either side of the wheel. In addition, the blades are double rim protected.

These are only a few of the reasons why the Terry solid wheel has become a "Trade Mark" for trouble-free turbine performance. For complete details, send for a copy of bulletin S-116. No cost or obligation.

THE TERRY STEAM TURBINE CO.
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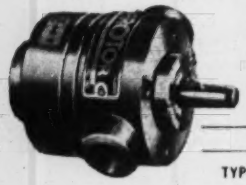
TERRY

TT-1197

There's a Gerotor Hydraulic Pump

to meet your requirements!

The GEROTOR line of precision engineered hydraulic pumps is designed to fill the requirements of the majority of hydraulic equipment users. The three standard GEROTOR models cover a range of g.p.m. delivery from .4 g.p.m. to 40 g.p.m. Check the capacity tables for the pump to fill your needs.



TYPE QDB

Gerotor's NEW QDB series of small capacity pumps . . . the last word in precision engineering.

Capacity Table

DELIVERY G.P.M. — 1800 R.P.M.					
TYPE	DISCHARGE PRESSURE P.S.I.				
	0	250	500	750	1000
QDB .4	.42	.40	.38	.35	.31
QDB .75	.84	.80	.78	.73	.66
QDB 1.5	1.67	1.62	1.57	1.50	1.42

TYPE QDH

The QDH . . . popular intermediate size of the Gerotor line

Capacity Table

DELIVERY — G.P.M. AT 1200 R.P.M.							
TYPE	DISCHARGE PRESSURE P.S.I.						
	0	250	500	750	1000	1200	1500
QDH 3	3.3	3.2	3.1	3.0	2.9	2.7	2.5
QDH 5	5.6	5.4	5.3	5.2	5.1	4.8	4.4
QDH 8	8.6	8.5	8.4	8.3	8.2	8.1	7.8
QDH 12	12.9	12.8	12.7	12.5	12.3	12.2	11.8

TYPE O

Gerotor Series O . . . when larger capacities are needed

Capacity Table

DELIVERY — G.P.M. AT 1200 R.P.M.					
TYPE	DISCHARGE PRESSURE P.S.I.				
	0	250	500	750	1000
0-20	20.0	19.5	18.8	18.0	17.2
0-25	25.0	24.5	24.0	23.2	22.2
0-30	31.2	31.0	30.5	29.8	29.0
0-40	43.0	42.5	42.0	41.5	40.0

Whatever your needs in hydraulic pumps . . . consult the GEROTOR engineers. Write for FREE literature and information, no obligation, of course.

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GEROTOR

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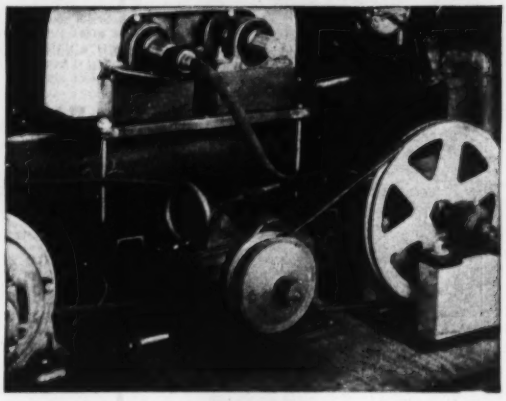
the right speed always to FIT THE JOB!

LOVEJOY

SELECT-O-SPEED

Variable Speed Transmissions



A Select-O-Speed Transmission is used here to drive and control the speed of a pulley and flexible shaft connected to a vibrator that checks vibration of vehicular components at changing speeds.

Lovejoy's accurate, easily installed Select-O-Speed Transmission gives you complete and instant speed control on all types of machinery—new or old. Even while the machine is running you can adjust to an almost infinite number of speed variations.

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Mfrs. of flexible couplings, universal joints, variable speed pulleys and variable speed transmissions.

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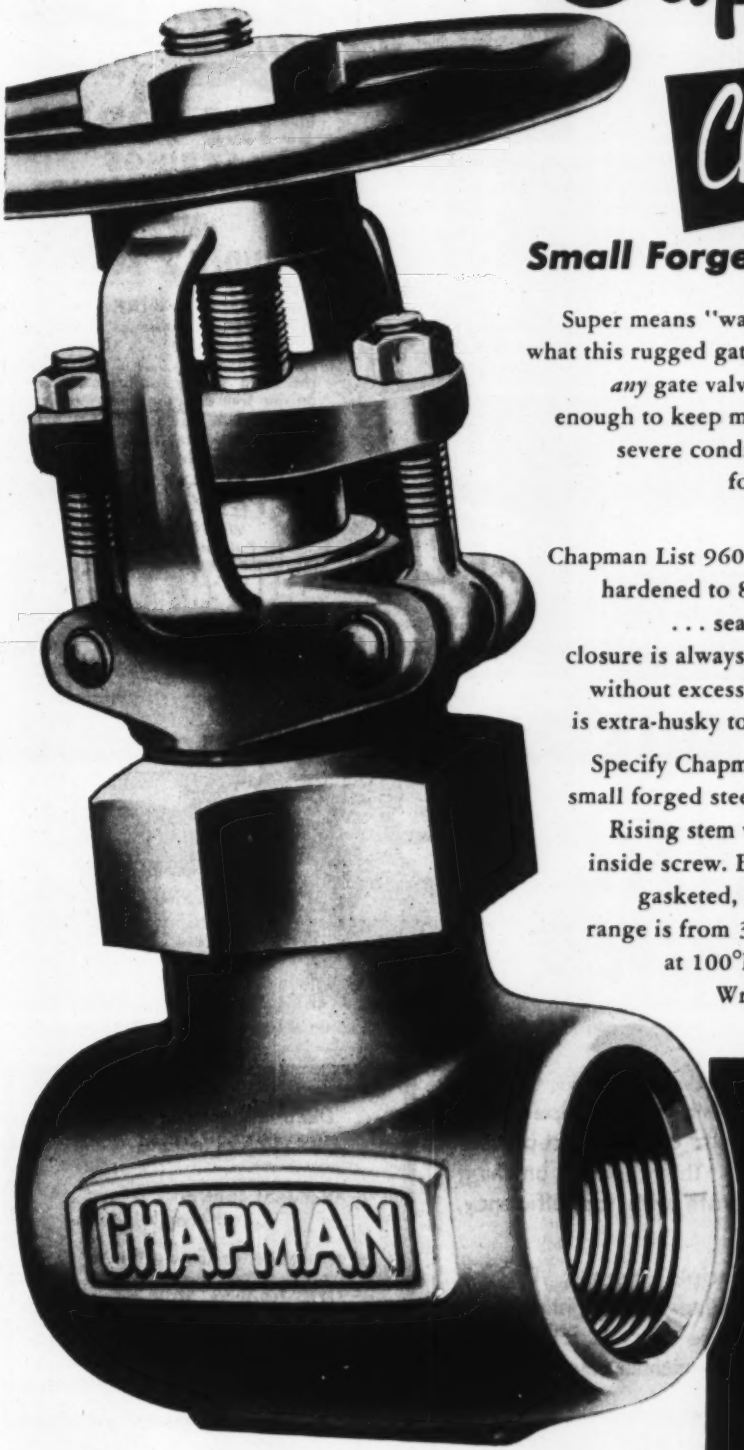
Chapman List 960

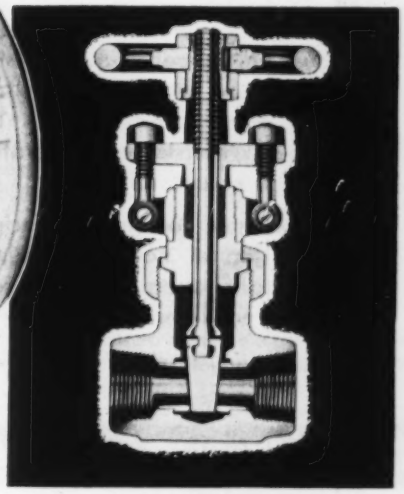
Small Forged Steel Gate Valve



Super means "way beyond the ordinary" and that's just what this rugged gate valve is . . . it's tough enough to lick *any* gate valve problem in its range . . . dependable enough to keep maintenance costs down under the most severe conditions. That's why List 960 is specified for more different applications than any other valve of its kind.

Chapman List 960 is tough because . . . wedge faces are hardened to 800 Brinell, so they won't seize or gall . . . seat rings are hardened stainless steel, so closure is always tight and operation is always smooth, without excessive wear . . . stem-and-gate connection is extra-husky to stand up under even unusual stresses.

Specify Chapman List 960 for every use you have for small forged steel gate valves. In sizes from ¼" to 2". Rising stem with yoke (shown) or rising stem with inside screw. Bonnet joint is either metal to metal or gasketed, depending upon application. Pressure range is from 380 pounds at 1000°F to 2000 pounds at 100°F. For higher ratings, specify List 990. Write today for your copy of Catalog 10.



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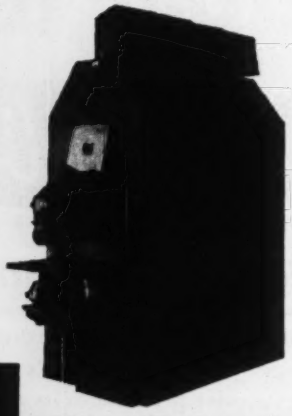

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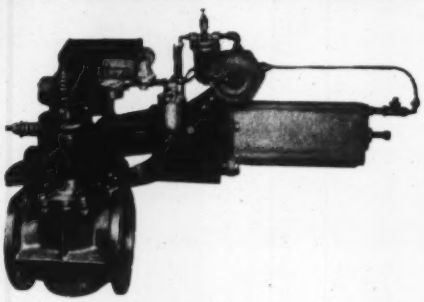
AUTOMATIC CONTROL VALVES



DeZurik Easy-Operating Plug Valves equipped with positioning type air and hydraulic operators represent the finest in automatic valving. They handle *anything* from gases to slurries and operate with top efficiency, *even on high vacuum services!*

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DeZurik Automatic Control Valves feature:

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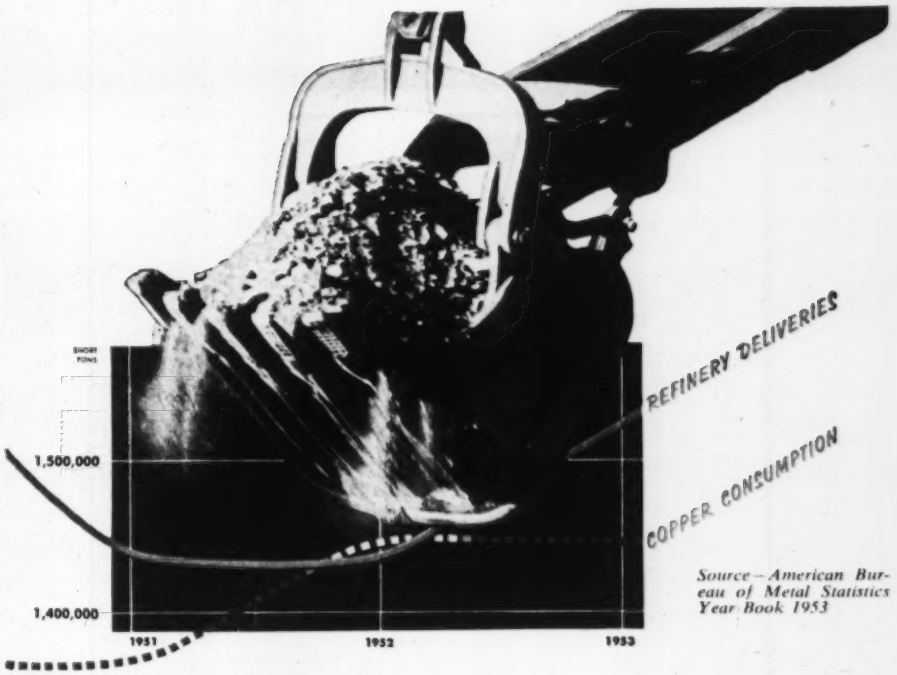
- — straight-thru flow
- — sizes from ½" thru 20"
- — all castable metals

AND they're attractively priced!

DeZURIK SHOWER COMPANY — SARTELL, MINNESOTA



Source—American Bureau of Metal Statistics Year Book 1953

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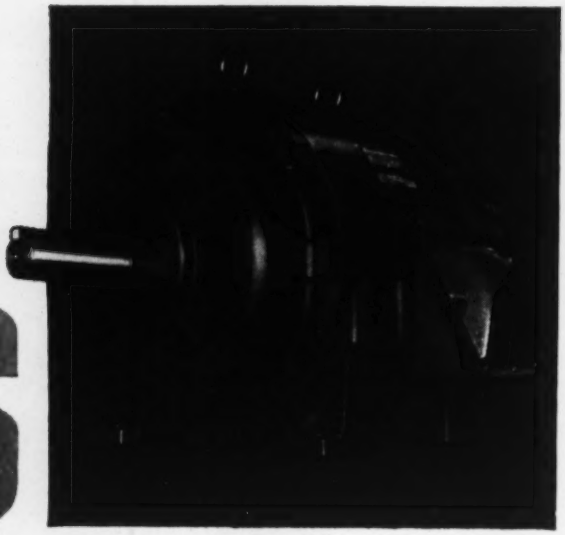
"ALL MOTORS ARE NOT ALIKE!"



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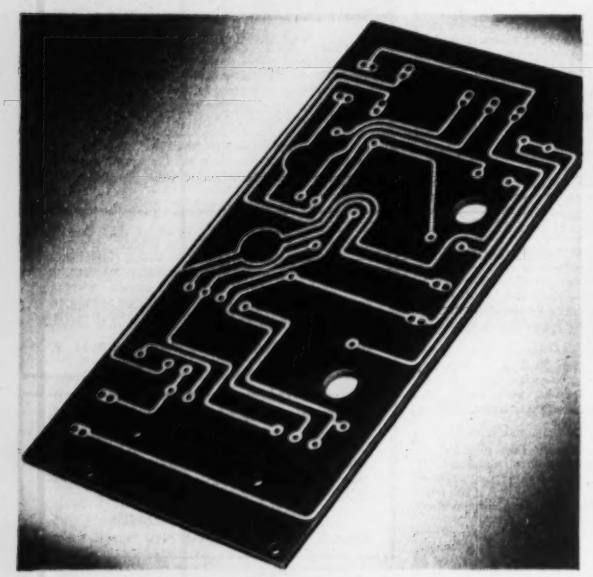

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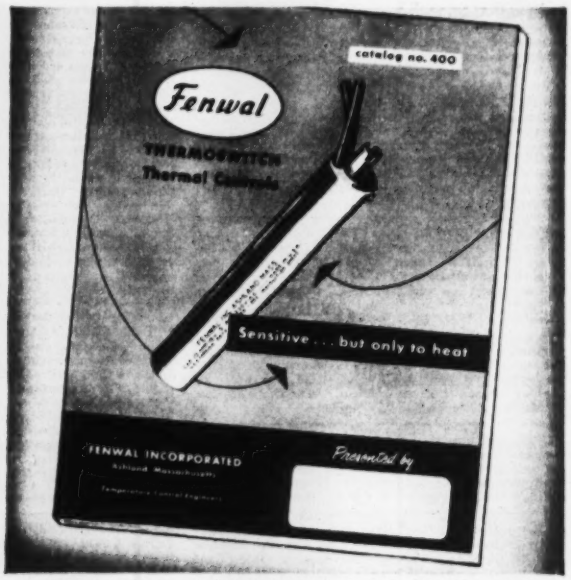

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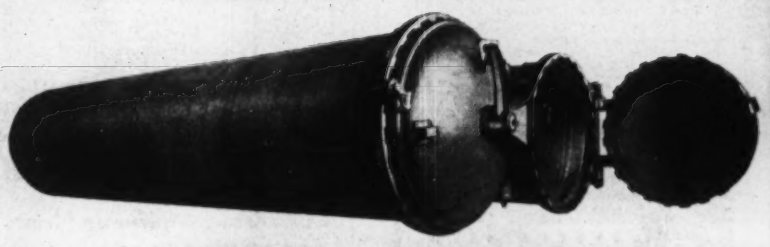

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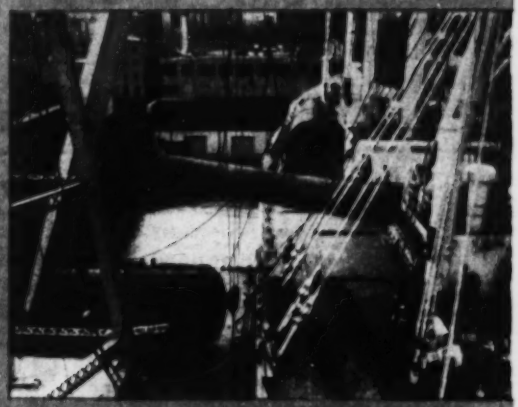

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Bell Telephone Laboratories
Boston Gear Works
Bundy Tubing Co.

Carboloy Dept. of General Electric Co.
Carborundum Co.
Catalytic Combustion Corp.
Chikaan Co.
Clearprint Paper Co.
*Cleaver-Brooks Co.
*Cochrane Corp.
*Coffin, J. S., Jr. Co.
Coppus Engineering Corp.
Corthead, Ralph C., Corp.
Cunningham, M. E., Co.
Cuno Engineering Corp.

Detroit Harvester Co.
Pioneer Pump Div.
*Detroit Stoker Co.
Diamond Power Spec. Corp.
Dow Corning Corp.

Ellison Draft Gage Co.
Engineered Precision Casting Co.

*Farrel-Birmingham Co.
*Flexitallic Gasket Co.
*Flexonics Corp.
*Foote Bros. Gear & Machine Corp.

*Garlock Packing Co.
General Radio Co.
*Gould's Pumps (Inc.)
*Grinnell Co.
Hamilton Mfg. Co.
Higgins Ink Co.
*Hoffman Combustion Engineering Co.
*Hydropress (Inc.)

*Illinois Gear & Machine Co.
Instrument Society of America
International Correspondence Schools
Irving Subway Grating Co.

John Thompson-Leonard, Ltd.
*Johns-Manville

Kellogg, M. W., Co.
Kennametal (Inc.)
Key Co.

Lefax
Lenape Hydraulic Pressing & Forging Co.
Little, Arthur D. (Inc.)
Lonergan, J. E., Co.
*Lummus Co., Fabricated Piping Div.

*Marlin-Rockwell Corp
Midwest Piping Co.
Mycalex Corp. of America

Nagle Pumps (Inc.)
*National Airoil Burner Co.
National Valve & Mfg. Co.
New York Air Brake Co.
Nicholson, W. H. & Co.
Northern Blower Co.

Ohio Gear Co.
Ohio Injector Co.

Pacific Pumps (Inc.)
Petro
Philadelphia Gear Works
Pittsburgh Piping & Equipment Co.

*Republic Flow Meters Co.
Research Corp.
Ric-Wil Co.
Ronald Press Co.
*Roots-Connersville Blower Corp.
Rotary Seal Co.
Roth Rubber Co.

Sanborn Co.
*Schutte & Koerting Co.
*Seamlex Co.
Sheffield Corp.
Sparta Mfg. Co.
*Spence Engineering Co.
Spraying Systems Co.
Streeter-Amet Co.

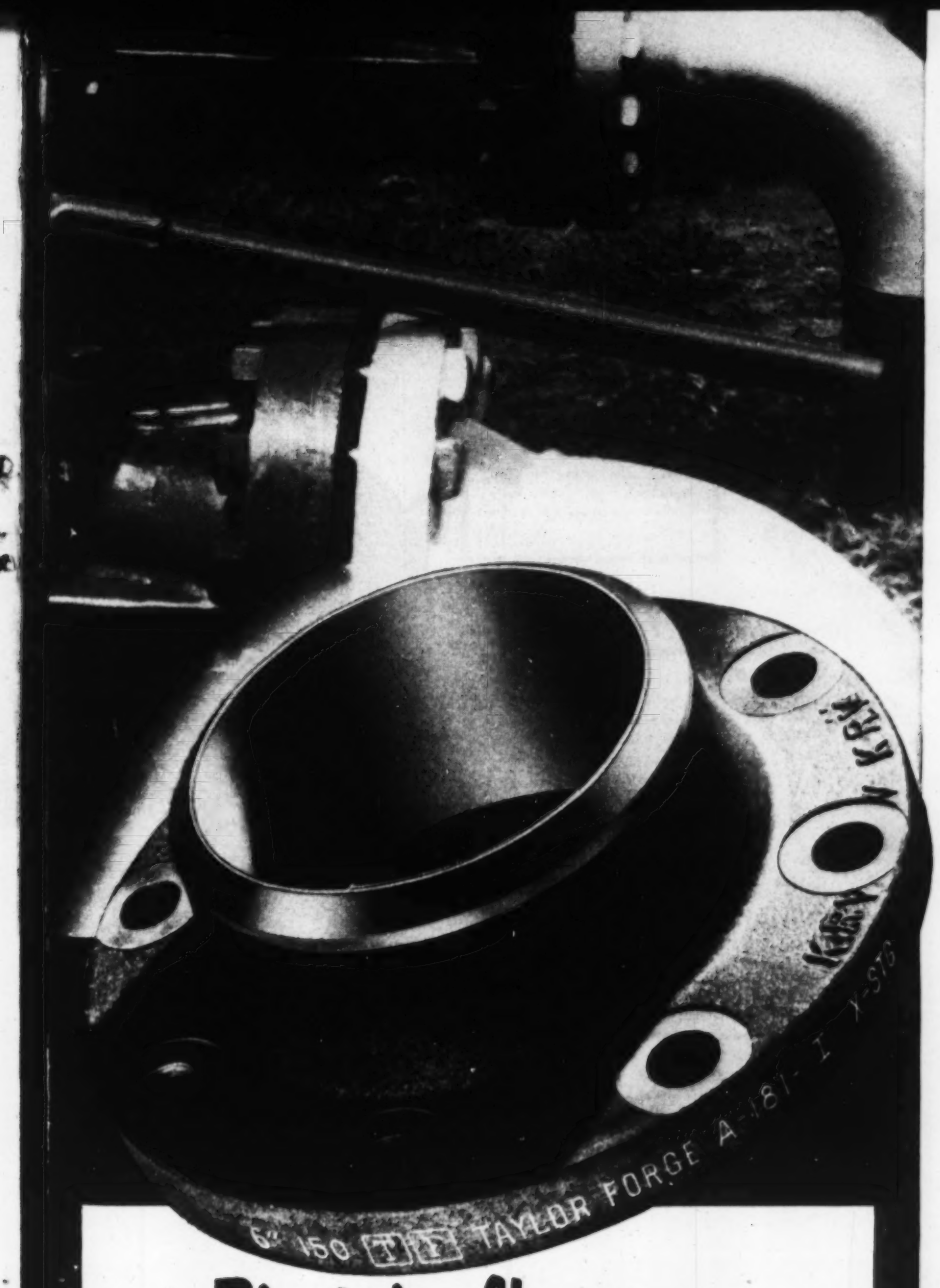
Taylor Dynamometer & Machine Co.
Thompson-Bremer & Co.
Trane Co.
Trimount Instrument Co.
*Tube Turns (Inc.)

Vickers (Inc.)
Div. Sperry Corp.
*Voss, J. H. H., Co.

*Western Gear Works
*Wickes Boiler Co.
Div. of Wickes Corp.
Wiley, John & Sons
Williams Gauge Co.
Wisconsin Motor Corp.

Yoder Co.

Zurn, J. A., Mfg. Co.



First in flanges—

No organization has been so closely identified with the development of forged steel flanges as Taylor Forge. No organization or individual has had so much to do with the study of design, strength, bolting practices, and the establishing of flange standards.

Taylor Forge started first and has remained first . . . in scope of flange types, sizes, weights, and materials . . . in volume produced.

See your Taylor Forge Distributor for up-to-the-minute facts.

TAYLOR FORGE

TAYLOR FORGE & PIPE WORKS • General Offices and Works: P.O. Box 485, Chicago 90, Illinois

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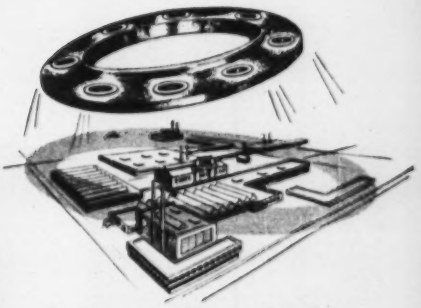


A flange with a future—

Even though no one knew it at the time, the year 1905 was a significant year for Taylor Forge.

It was the year that Taylor Forge began the making of forged steel flanges.

The beginning was modest enough. Taylor Forge simply started out to make flanges for Taylor Spiral Pipe because the only flanges then available – cast iron flanges—had proved unsatisfactory. But it was soon apparent that the men at Taylor Forge had built better than they knew. In just a few years, the new and stronger Taylor Forge Flanges were in demand everywhere—not just for Taylor pipe, but for all types of pipe used by U. S. industry.

It was also apparent that the forging of flanges had taken Taylor Forge into the dawning field of designed piping. Pressures were beginning to climb. Knowledge of how to contain them was needed. By 1920, the late J. Hall Taylor and his associates began the intensive research that was to make Taylor Forge not only the world's largest manufacturer of forged steel flanges, but also the foremost contributor to flange design and standards.

In the mid-20's, big strides were made in flange development to meet the broadened needs of the growing petroleum industry. By 1927, as the reward of long, intensive research, the authoritative Taylor-Waters formula was published. This research work demonstrated the design advantages of the hub type flange and provided the means for producing flanges accurately proportioned for strength combined with economy.

Most of this research had been concerned with the American Standards—flange sizes through 24"—but in 1938 Taylor Forge published the first edition of its widely consulted "Modern Flange Design," based on methods proposed by E. O. Waters, D. B. Rossheim, D. B. Wesstrom and F. S. G. Williams, manager engineering standards, Taylor Forge (ASME Trans. Apr. 1937). It provided the first complete analyses of the effects of tapered hubs on flange strength and thus opened the way to predetermine design requirements of flanges of all types.

(An episode in the story of Taylor Forge leadership in designed piping)

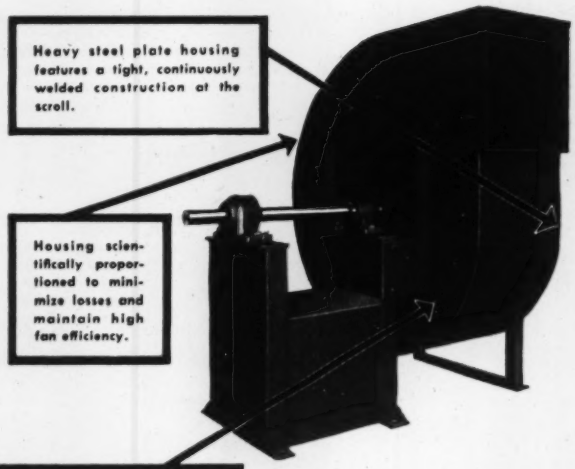
Forty years of research made this book possible. It is available to those interested in flange design.

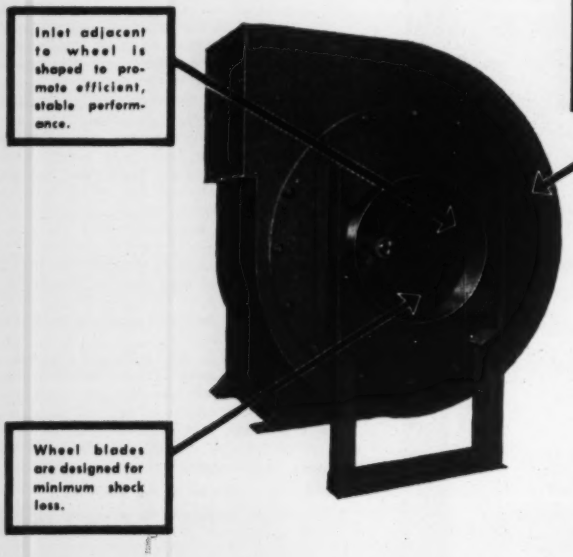
Announcing

the new Clarage TYPE XL Industrial Fans

Exceptional Fan Equipment distinguished by:

1. High efficiency characteristic.
2. Rugged, tight construction.
3. Three interchangeable wheels — each with radial blades.
4. Large size range — 11″ through 60″ inlet diameters.
5. Pressures to 18″ SP; volumes to 130,000 CFM.


Heavy steel plate housing features a tight, continuously welded construction at the scroll.
Housing scientifically proportioned to minimize losses and maintain high fan efficiency.
Adjustable to any of eight standard discharges by merely removing tap bolts on each side and rotating the housing between the sideplates.


Inlet adjacent to wheel is shaped to promote efficient, stable performance.
Wheel blades are designed for minimum shock loss.

Type XL fans shown here are typical of the smaller sizes which provide universal discharge. Larger sizes are of reinforced sheet steel and base angle construction extending to the foundation line.

Send for Bulletin 702

A new, modern design offering many distinct advantages!

Clarage Type XL industrial fans are particularly well suited for diversified air and material handling applications. You'll profit from the high efficiency, in-the-field adaptability, and numerous other features of this exceptional fan equipment.

Learn more about these distinguishing features by requesting Bulletin 702, or contacting the nearest Clarage application engineering office.

CLARAGE FAN CO., Kalamazoo, Mich.

You can Rely on...

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Headquarters for Air Handling and Conditioning Equipment

SALES ENGINEERING OFFICES IN ALL PRINCIPAL CITIES • IN CANADA Canada Fans Ltd. 4285 R. Helen St. Montreal

Permutit Demineralizers deliver highest purity make-up for Illinois Power Company's new 1450 psi steam generator

Hennepin Power Station, Illinois Power Company. Steam Capacity 525,000 lb/hr. Consulting Engineers: Sargent & Lundy

This plant's 75,000 KW turbo-generator must operate continuously at high efficiency.

Tips of turbine blades turn at speed faster than sound. At these speeds, slight amounts of *silica* in make-up water quickly build *dangerous* deposits—destroy turbine efficiency, cause costly shutdowns.

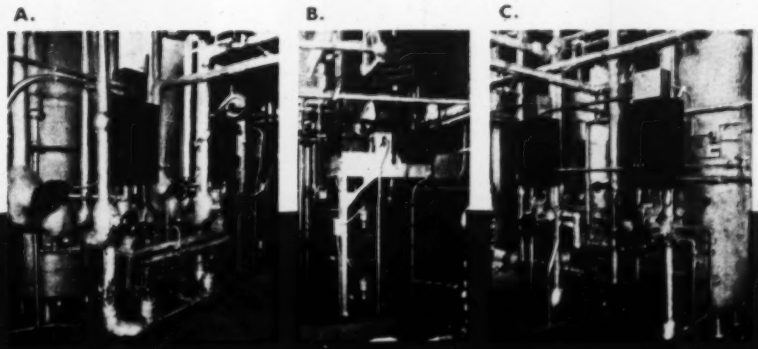
To prevent these troubles, all make-up water is demineralized by the Permutit equipment shown below. Silica is reduced from a harmful 14 ppm to as low as 0.02 ppm—*at low cost!* Total dissolved solids are reduced from 298 to 1.0 ppm!

This keeps 76 miles of boiler tubing free of scale with little or no blowdown. It permits the *high* heat-transfer rates demanded with 1010° F steam at 1450 psi.

Write to us for aid in solving your water problem. Permutit makes the world's most complete line of ion exchangers and water conditioning equipment. We can help save you time and money with the one combination that best suits your needs.

The Permutit Company, Dept. ME-9, 330 West 42nd Street, New York 36, N. Y., or Permutit Company of Canada, Ltd., 6975 Jeanne Mance Street, Montreal.

A. B. C.



A. *Automatic Permutit Q units remove metallic cations from well water supply.*

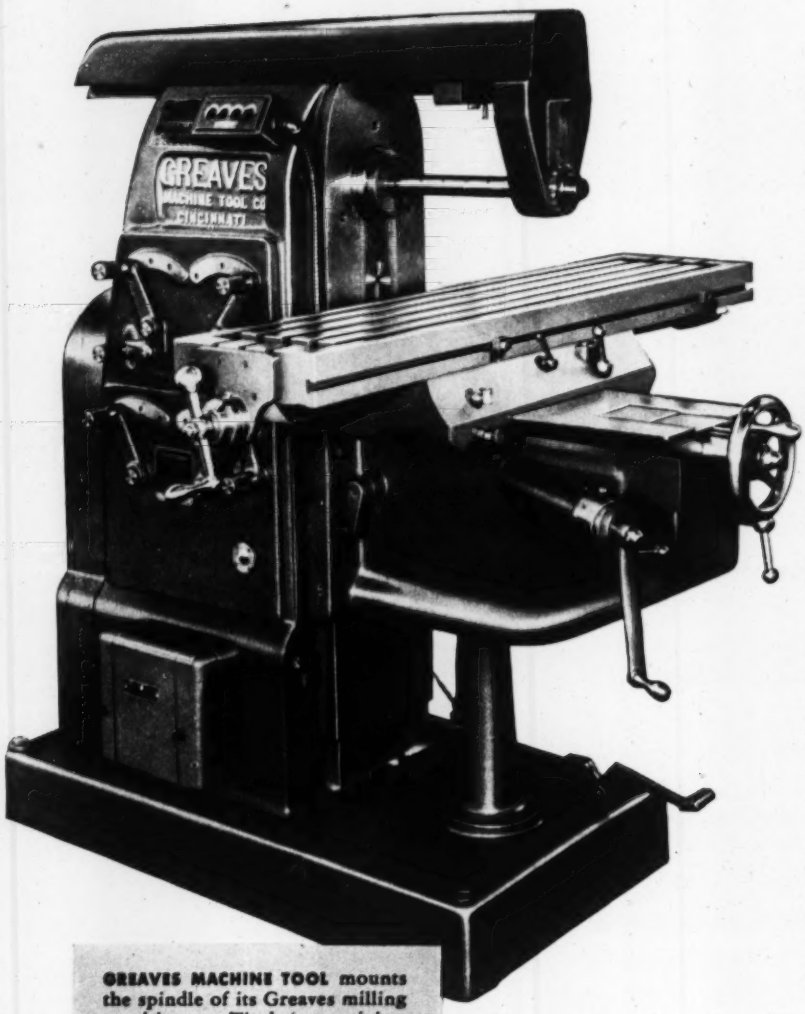
B. *Permutit Degasifier removes CO_2, reducing operating cost.*

C. *Automatic Permutit S units remove remaining troublesome mineral impurities by anion exchange.*

Ion Exchange and Water Conditioning Headquarters for Over 40 Years.

PERMUTIT®

18 feeds, 18 speeds—plus lasting precision with TIMKEN® bearings



GREAVES MACHINE TOOL mounts the spindle of its Greaves milling machine on Timken precision bearings to insure lasting precision.

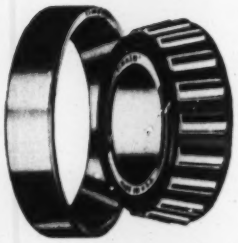
FOR 15 years, the Greaves Machine Tool Division of J. A. Fay and Egan Company have been assuring customers of lasting spindle precision by specifying Timken® tapered roller bearings for their machine tools. Typical example is this Greaves 2-H plain and universal milling machine which features 18 feeds and 18 speeds to provide the one best speed-feed combination for every type of work and material.

Used on the first and second intermediate shafts and on the spindle, Timken bearings take radial and thrust loads in any combination. Their tapered design makes this possible. Shafts are held in accurate alignment, assuring precision milling even after years of service. Line contact between rollers and races give Timken bearings extra load-carrying capacity.

The geometrically correct design of Timken bearings gives them true rolling motion; their accuracy lives up to the design. Result: Timken bearings practically eliminate friction. And to get the quality of steel to meet our exacting specifications, we make our own. No other U. S. bearing manufacturer does.

Under normal usage, Timken bearings last the life of the machine. Specify them in machinery you buy or build. Look for the trade-mark "Timken" on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

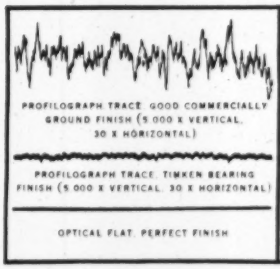
This symbol on a product means its bearings are the best.



TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS


PROFILOGRAPH TRACE, GOOD COMMERCIALLY GROUND FINISH (5 000 X VERTICAL, 30 X HORIZONTAL)
PROFILOGRAPH TRACE, TIMKEN BEARING FINISH (5 000 X VERTICAL, 30 X HORIZONTAL)
OPTICAL FLAT, PERFECT FINISH

SMOOTH TO MILLIONTHS OF AN INCH

Surface finish of high quality Timken bearing rollers and races is so smooth that it takes a profilograph to measure its smoothness. This instrument measures surface variations to a millionth of an inch, as shown at the left.

NOT JUST A BALL ○ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭ BEARING TAKES RADIAL ↓ AND THRUST →◎← LOADS OR ANY COMBINATION